POWER

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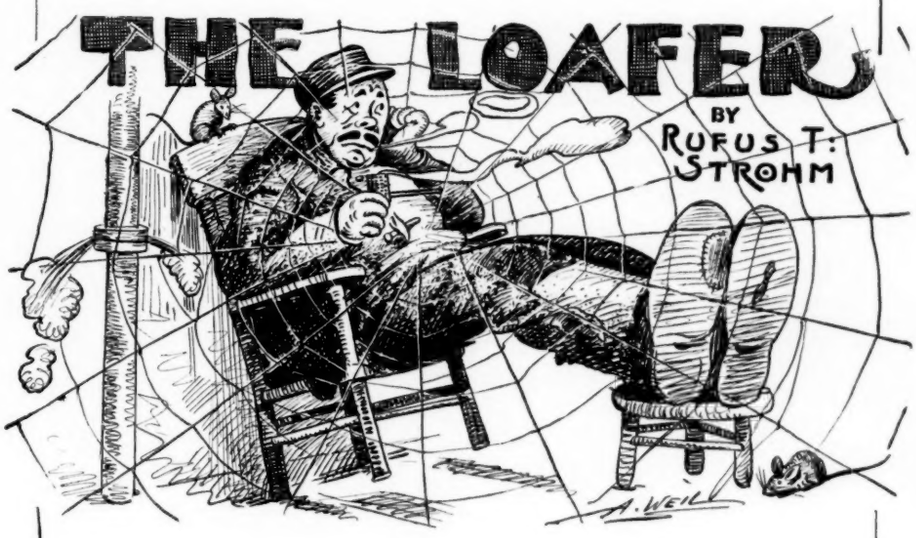


IF SOME untimely happening should cause your engineer
To leave you rather suddenly and hunt another sphere,
And you should be compelled at once to undertake a search
To find a substitute for him who left you in the lurch,
Put down the name of every man who's fitted for the place
And pay a visit to his plant, to see him face to face;
Discuss the matter thoroughly and fairly when you meet,
But notice if the pants he wears are shiny on the seat!

There's quite a chance for error and for getting off the track,
In judging what a man may be by what is on his back;
But though the clothes don't make the man, they very often show
A lot of things about the chap that one may wish to know;
So look him over, up and down, and make a mental note
Of nails in place of buttons on his jumper or his coat;
But while you mark the rags and holes that sadly need repairs,
Observe the bearing surface of the trousers that he wears!

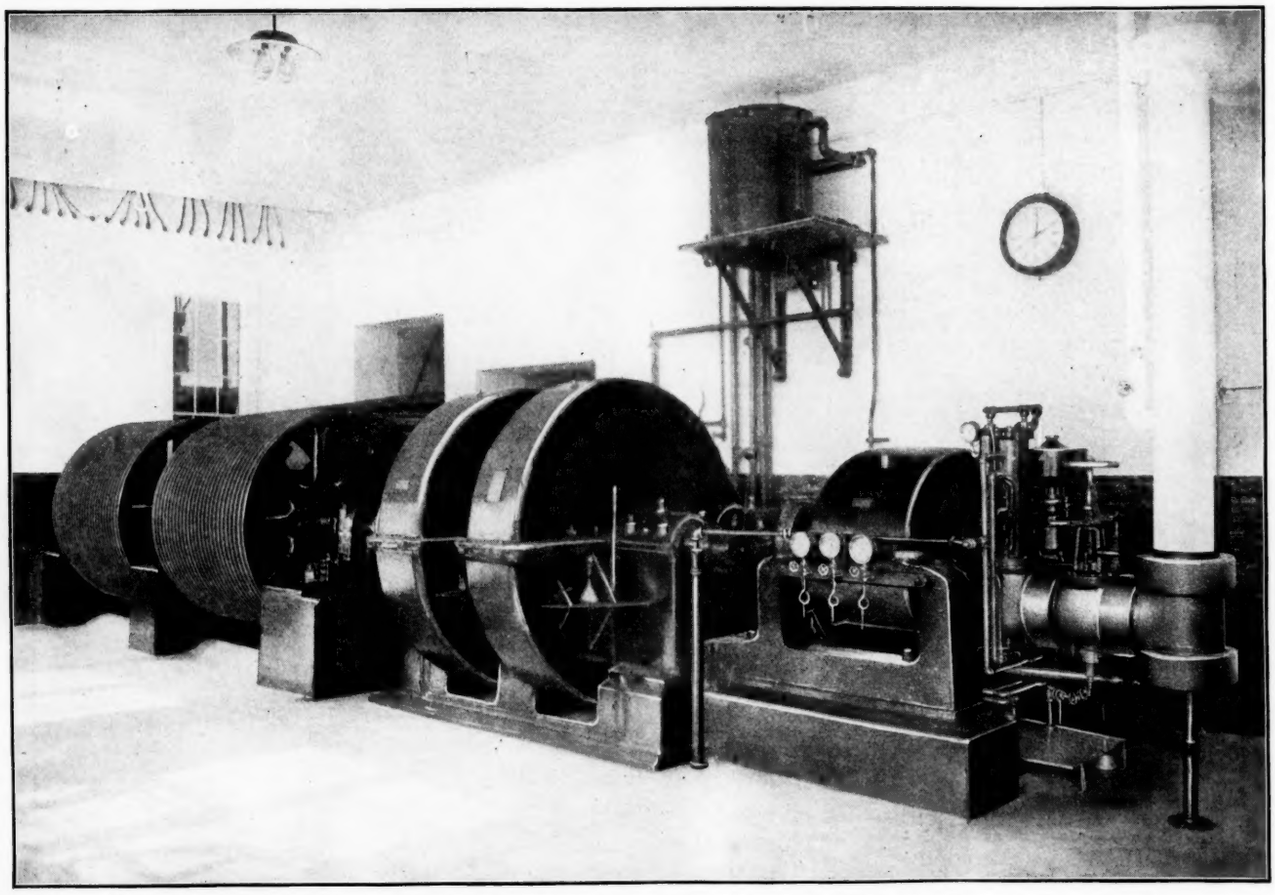
Just keep an ever-ready ear attuned to catch the sound
Of stuffing-boxes spitting steam or brasses prone to pound,
And while you listen quietly, allow your glance to seek
For every telltale evidence of carelessness or leak.
The man who runs a power plant and tries to run it right,
Has work enough to fill the time from early morn to night,
And if he tends to business, he'll be always on his feet,
So notice if his overalls are polished on the seat!

And if your swift and watchful eye detects a luster there,
The time for caution has arrived—take warning and beware!
It doesn't need an intellect extremely quick and keen
To calculate the loafing that results in such a sheen,
For only friction long sustained can set its shining seal
Upon the woven fabric or the marble or the steel;
So you may well consider it a damning circumstance
To find a glossy finish on the bosom of his pants!

Turbine Rope Drive with Reduction Gear

SYNOPSIS—Reasons why a steam turbine with reducing gear and a rope drive to the mill lineshafts were used in combination with several waterwheels. This unit displaced a vertical steam engine and was installed at a cost about 90 per cent. less than that of a motor-driving system including motors, wiring, generators, etc. It was estimated that the friction losses in the lineshafts, etc., would not be any more than the losses in the generators, motors, wiring and group shafting.

At the power plant of the Jackson mills of the Nashua Manufacturing Co., Nashua, N. H., there is a steam turbine that is transmitting power to two lineshafts in the mill through rope drives and a reduction gear.



DE LAVAL 1600-HP. TURBINE WITH REDUCTION GEAR AND ROPE DRIVES

The first question that naturally arises in the mind of the engineer is: Why were rope drives used instead of motors in the mill that could be driven by energy generated by a turbo-generating set, so long as a turbine was to be installed? In every engineering proposition there are one or more conditions that govern the selection of certain types of apparatus, and the Jackson mill was no exception.

One factor, and probably the least that governed the selection of a rope drive from a turbine unit, was that the engines were getting old. Originally the mill had been driven partly by several waterwheels and partly by two vertical steam engines that were located in widely separated engine rooms, and their operation was uneconomical.

These conditions resulted in the installation of a 1000-kw. turbo-generator in 1913, and two of the waterwheels that had supplied power to outlying buildings were belted to generators. These units supplied current for motor drive in such portions of the mill as were the worst off mechanically.

The new turbine room was built adjacent to the engine room, between the river and the main mill building, on land that had not previously been occupied for other purposes. This 1000-kw. turbine was placed opposite a 22 and 46 x 36-in. vertical engine that was belt-connected to two lineshafts. This engine and several waterwheels drove the main mill. As the engine was located in the mill proper, the engine room occupied valuable floor space that could be utilized to better advantage for manufacturing purposes, and it was for this and other reasons decided to remove the engine and put in some other type of main driving unit. However, the lineshafts were in good condition, and changing to motor drive would mean decided alteration in the mill as well as discarding the waterwheel power in the main mill unless they were used to drive generators, all of which would be expensive.

Water available for power purposes varied greatly with the seasons of the year, which made it necessary to main-

tain sufficient steam reserve capacity to carry the mill regardless of the stage of water. This fluctuation of the waterwheel load complicated things in the matter of flexibility of the system. It was estimated that it would cost $55,000 to install a motor-driven system with generator and wiring complete, or about 90 per cent. more than the actual cost of a building and the equipment for a direct drive through a turbine reduction gear and ropes to the original lineshafts. It was also estimated that as the lineshafts were in good condition, the over-all friction loss from mechanical drive of the turbine to the machinery pulleys would not be any more, and probably less, than the loss that would result in the generator, wiring, motors and the group shafting. These are the main reasons why a direct-driving turbine was installed. It is in the same room with the 1000-kw. unit.

This unit consists of a 1600-hp. De Laval high-pressure steam turbine equipped with a single reduction gear that changes the turbine speed of 3280 to 308 r.p.m. There are two 64-in. sheave wheels on the driving end, each carrying twenty-four $1\frac{3}{4}$-in. ropes connecting to the two lineshafts, which are on two levels and left practically the same as when engine-driven except that sheave wheels replaced the belt pulleys. The distances between these shaft centers and the driving sheaves are, bottom shaft $57\frac{1}{2}$ ft., top one 60 ft. A jet-type condenser is located in a basement below the turbine and an average vacuum of 28 in. is maintained.

Under the present arrangement the outlying buildings of the mill are driven by motors, the energy for which is supplied by the 1000-kw. turbine and the two waterwheel-driven generators. The new direct-driving turbine with several waterwheels drives the main portion of the mill. The load on the turbine depends upon the stage of the water. Naturally, the waterwheels are worked to full capacity, and the turbine supplies whatever power is necessary to keep the mill running at normal speed, floating on the line, as it were. This installation was laid out by John A. Stevens, M. E., of Lowell, Mass.

It is understood that about four years ago the first application of turbine mechanical drive, a 700-hp. unit, was used for driving a mill and that two such units have since been installed in India, one of which was of 1250-hp. capacity. This unit with a single reduction gear gave a driving speed of 300, reducing from 3000 r.p.m. Another installation in this country is at the Pemberton Mills, Lawrence, Mass., where a 375-hp. De Laval turbine with a speed reduction from 6000 to 600 r.p.m. transmits power partly through a belt to a mill lineshaft and partly through a 150-kv.-a. alternating-current generator, both from the low-speed shaft. It is used as a relay to water power and operates with a varying load.

Visits of Inspector Brown—XXX

By J. E. Terman

SYNOPSIS—Girth seams of return-tubular boilers are discussed, and the Chief explains to Brown that the lap and rivet spacing of such a seam is a vital factor, as the path of least resistance for the transmission of the heat to the water in the boiler is through the shank of the rivets, and that all the plate surface immediately beneath the rivet heads cannot absorb heat from the furnace.

"Say, Chief," said Brown, as they were leaving the office to make an inspection at a mill out of town, "I wish you would tell me the reason for this order about making the girth seams on horizontal return-tubular boilers for Detroit, so that the efficiency will be at least 50 per cent. figured on the shear of the rivets. I can't see any good reason for such a requirement, for there is not half as much load on these seams as on the longitudinal seams due to the pressure in the boiler. Besides, if the boiler were only a cylinder without tubes or through braces, the requirements for strength to care for the stresses produced by internal pressure would be that the strength of the girth seams should be one-half that of the longitudinal seams. This requirement would call for considerably less than 50 per cent. efficiency for the girth seams, even with quadruple-riveted longitudinal seams."

"Well, Brown, the chief of the Boiler Inspection Department of the City of Detroit knows a thing or two about boiler design, and you can bet on it that there is a good reason for making that requirement or the chief inspector thought he had one when he made it. I have made inquiry as to just what was intended, and I find that it is not a matter of strength at all, but a desire to secure closer spacing of rivets on the girth seams of boilers of the horizontal return-tubular type, which is a mighty good plan. Suppose you apply some of the experience that you have now gained in the field to the solution of the problem of determining just how the girth seam on a horizontal return-tubular boiler should be designed," said the Chief. "It has become customary, whenever a riveted joint is considered, to dwell almost entirely on its strength, and that is no doubt the reason that you have considered only that feature of the Detroit requirements. Aside from the abandonment of the lap seam to avoid the lap-seam crack, boiler inspectors rarely consider any question but strength in discussing riveted joints. It is doubtful in my mind, Brown, if the abandonment of the lap seam could have been secured at all if it were not for the fact that it is a much weaker seam and it actually costs more money to use it in the average case for high-pressure boilers.

"Trouble at the girth seams in horizontal return-tubular boilers is one of the few inherent troubles with this type of boiler, and there appears to be less attention paid to the design of these seams than to almost any other portion of the boiler. This is no doubt the case because it is reasoned that any joint will be sufficiently strong to resist the stresses that may be brought on such seams. The most important function of a girth seam is to get rid of the heat delivered to it without overheating the outer lapping plate. What do you find to be the chief source of trouble with girth seams?" asked the Chief.

"Why, I think that leakage may be said to be the thing that most frequently causes trouble; fire cracks also occur on these seams, sometimes before leakage occurs," an-

swered Brown. "If the leakage is not too bad and the rivets are all tight, I order the seam chipped and calked."

"Why do you order the seam chipped?"

"Well, Chief, I didn't order the chipping of the seams when I first started out unless the edge looked bad, but I soon found that calking alone rarely ever made a permanent job, and I reasoned that it was necessary to cut back the edge to get a new and smooth surface on the underlying plate, in order to calk the edge of the upper plate tight against it."

"That was good reasoning, and you have adopted the right plan. You will notice that about all experienced boilermakers invariably insist on cutting back the calking edge in such instances. One will tell you that he does it to get rid of the damaged metal along the calking edge on the outer lapping plate; another will say that he cuts off some of the edge from the lap in order to get a stiffer edge to calk; still another will claim that he wants to get a new surface on the underlying plate to calk against, just as you have assumed would be the proper thing to do. All these reasons are good ones and contribute toward making the job permanently tight.

"There is one reason for cutting back the lap that the boilermaker will rarely give and I think it is probably the most important one of all; and that is, that such a change shortens the lap. Experience shows that the transmission of heat from one piece of metal to another is not at all good unless the pressure between the two surfaces in contact is very high. In the average girth seam it is doubtful if the plates are in very close contact over the larger portion of the area between the inner and outer plates, much less being pressed together heavily over this area. This being the case, it is doubtful just how much heat is transmitted from the outer plate to the inner one; possibly only a small area immediately around the rivet holes serves to transmit heat in this way, therefore there must be some other path for the heat delivered to the outer lap to reach the water in the boiler. Naturally, the only path left is endways of the plate through the outer lap, shown here by the arrows," said the Chief, drawing Fig. 1. "If this is the case, you can readily see that the amount of lap on a girth joint is a vital factor. That is, cutting off a piece along the calking edge shortens the path of the heat travel and also reduces the amount of surface exposed to the action of the flames and heated gases, and in both ways tends to reduce the punishment imposed on the outer lapping plate."

"Why, I never thought of that, Chief, but it must be so."

"Yes, Brown, but that Detroit chief inspector has thought of that feature of the case, for if you remember, he requires that the lap on girth seams be *not over* one and one-half rivet-hole diameters, instead of making this a minimum requirement. Of course," continued the Chief, "any other change besides the cutting back of the lap that will reduce the amount of surface exposed to the furnace heat will tend to make girth seams tight and free from fire cracks. Such a result may be accomplished by the closer spacing of the rivets along these seams. That is just what the Detroit inspector is trying to do in making his specifications for the strength of such seams. All the plate surface immediately beneath the rivet heads cannot absorb heat from the furnace, because the path of least resistance for the transmission of this heat to the water in the boiler is through the shanks of the rivets. Therefore, if the rivet heads are twice as numerous in one case as another, the amount of surface protected by them will be twice as great. Of course, this is an absurd illustration, Brown, but I am stating it to show you the principle of the thing. Another thing that the close spacing of the rivets accomplishes, which also is the same as one of those secured by the cutting back of the calking edge, is that it stiffens the edge of the plate and makes tighter calking possible, and this stiffness also tends to prevent the stresses set up by expansion and contraction, which are no doubt the principal ones that the girth seams are called upon to resist, from working the joint loose along the calking edge. To get a better grasp on the principles involved, suppose we consider a practical example. For the sake of simplicity we will take 1-in. rivet holes and assume that the edges of the plates are lapped just three rivet-hole diameters." (See Fig. 2.) "Then three times the length in inches of any section of such a joint will represent the number of square inches of plate and projected area of rivet heads exposed to the action of the furnace heat along the seam. Suppose the plate is ½-in. thick and the pitch of rivets along the seam is 3 in., which I am sure you will admit is not beyond the pitch you have often seen used under such conditions. Take a 3-in. length of this seam and the rivet heads cover 2.405 sq.in., since the diameter of the heads are 1.75 times the shank diameter. Therefore, in a 3-in. length of this seam there is exposed $3 \times 3 - 2.405$, or 6.595 sq.in. of plate to the direct action of the furnace heat. Assume," continued the Chief, "that this joint is changed so that the rivets are spaced as close together as practical, say the rivet heads are only ½ in. apart; that is, the pitch of the rivets is 2¼ in." (see Fig. 3). "Also assume that instead of

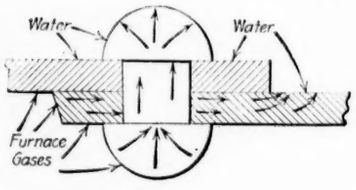


FIG. 1. SHOWING PATH OF HEAT TRAVEL

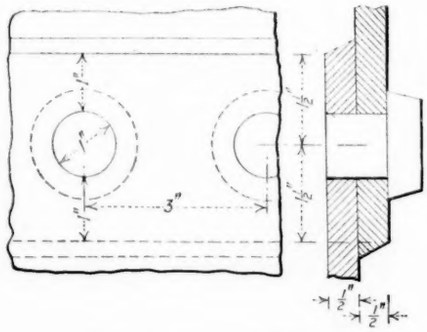


FIG. 2. RIVETS SPACED 3 IN. CENTERS

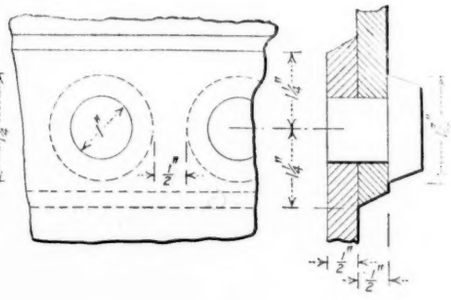


FIG. 3. HEADS OF RIVETS ½ IN. APART

having the distance from the center of the holes to the edge of lap 1½ in., as before, this distance is made only 1¼ in. Then in a 3-in. length of joint there would be exposed 4.295 sq.in. of the outer lapping plate that would not be protected by the rivet heads. To take account of all the exposed surface it is necessary to include the surface of the end of the plate along the calking edge, which in both cases would amount to $\frac{1}{2} \times 3 = 1\frac{1}{2}$ sq.in. Thus in one case the total area exposed would be 8.095 sq.in. and in the other 5.795 sq.in. This means that there is nearly 40 per cent. more exposed surface in one case than in the other. Another advantage that has been gained by the reduction in the width of the lap is that the main path for the transmission of heat has been reduced in length by ½ in., or over 16 per cent."

"That should make some difference," said **Brown.**

Good and Bad Girth Seams

"It does," replied the Chief, "and that is often the difference between good and bad girth seams. Of course, seeing that the rivets are spaced close and that the lap is short are not the only things that are necessary to make a good girth seam, for the fit of the courses is a big thing in keeping a girth seam tight. This in my opinion, Brown, is not because the closer fitting of the plates tends to particularly improve the conductivity between the two plates at the lap, because I don't believe that there is any material change in this respect in the two cases; but with poor-fitting courses the plate at each rivet hole has been put under severe stress by the act of riveting. With poor-fitting courses the edge of the plate is in such a condition that it cannot be calked to the best advantage, and the plates also tend to pull apart at the calking edge when the expansion and contraction strains come upon the joint."

"Well, Chief, how about the specifications of Detroit, that the efficiency of the girth seams must be 50 per cent. or over when figured on the shearing of the rivets? Don't that secure the best design of girth seams for horizontal return-tubular boilers?"

Intent of Specifications

"The intent of that specification is all right, Brown, which is that large rivets closely spaced be used in the design of the girth seams, but I feel the specification is not complete enough to insure that the desired conditions will be obtained every time. My idea of a specification for the design of girth seams for horizontal return-tubular boilers would be: P must be less than $1.75d + 0.7$; and E must be more than 50 per cent., where P is the pitch of the rivets in inches; d the rivet-hole diameter in inches; E the joint efficiency.

"Since the diameter of the head of a standard button-head or cone-head rivet is 1¾ times the shank diameter, the pitch I have specified should give sufficient room between the heads to permit driving. Of course, this specification would mean close-spaced rivets, but that is what is necessary in the girth seams of horizontal tubular boilers if they are to stay tight in service. The fixing of minimum joint efficiency in addition to the maximum pitch allowed places a limit on the plate thickness that may be used with a given size of rivet. I have a table in my notebook," said the Chief, "where I have worked out the maximum pitch values and the maximum plate thicknesses that could be used under such specifications.

"The values in this table were secured by using 44,000 for the shearing strength of the rivets and 55,000 for the

MAXIMUM PITCH AND MAXIMUM PLATE THICKNESS

To Be Used for Different Rivet-Hole Diameters in the Proper Design of the Girth Seams of Horizontal Return-Tubular Boilers

Rivet-Hole Diameters, In.	Max. Pitch of Rivets, In.	Max. Plate Thickness, In.	Rivet-Hole Diameters, In.	Max. Pitch Rivets, In.	Max. Plate Thickness, In.
⅞	1.794	0.273	1	2.45	0.512
15/16	1.903	0.312	1 1/16	2.56	0.554
15/16	2.012	0.351	1⅛	2.67	0.596
1 1/16	2.122	0.391	1 3/16	2.78	0.637
1 1/16	2.231	0.431	1¼	2.89	0.680
1⅛	2.340	0.472	1 5/16	3.00	0.722

tensile strength of the plate, the same as used in the Boiler Code of the American Society of Mechanical Engineers.

"You see," continued the Chief, "the only difference between these specifications and those of the City of Detroit is that there is a maximum limit for pitch specified, and without this limit the rivets might be spaced too far apart where the plate was relatively thin for the rivet size used. For example, ⅜-in. plate with 1-in. rivet holes would permit the rivets to be spaced more than 3¼ in. apart and still fulfill the requirements of the Detroit specification. Of course, where the plate is thin, there is all the more need for spacing the rivets close, in order to produce a girth joint that will be tight and remain so in service.

"I believe that if you will give Casey's foreman a copy of this table to follow and see that the layer-out makes the courses so that they will fit tight, and prevent the men on the 'bull' from driving the girth rivets too fast, many of the girth-seam troubles that have been experienced with the boilers Casey's shop turns out will be avoided."

"That is a good tip, Chief. I will have a heart-to-heart talk with that foreman the very next time I go to the shop. I notice from that table, Chief, that the maximum plate thickness that could be used with the largest rivet that Casey can drive (1 5/16 hole diameter) is a little less than ¾ in. How about thicker plates?"

"Why, you understand that this table is intended to apply only to the girth seams of horizontal return-tubular boilers, Brown. It is a good thing to restrict in some way the plate thickness that may be used in this type of boiler, and the fact that the Detroit specification for girth seams in effect places a limit to the plate thickness that may be used for this type of boiler is most desirable.

The Idaho Power Co. has recently filed with the county recorder at Pocatello, Idaho, a first mortgage covering all its properties in Idaho and Oregon, as the first step in the refinancing of the many power companies throughout the Northwest which it took over some time ago. The mortgage runs to the Bankers Trust Co. and Fred I. Kent, both of New York, as trustees. It provides for a present issue of $4,500,000 in 5 per cent. bonds secured by this first mortgage, which specifies in detail the only basis upon which future bonds can be issued up to $100,000,000. All the properties now owned by the Idaho Power Co. were acquired at receivership sales following financial difficulties, and the merger was completed after a full hearing before the public-utilities commission and the governor of Idaho, at which time the plan for refinancing the merger was discussed and approved. The various companies involved had issued and sold first and second mortgages as follows: Idaho-Oregon Light and Power Co., $4,257,000; Boise-Payette River Electric Power Co., $475,000; Interstate Light and Water Co., $35,000; Idaho Railway, Light and Power Co., $8,449,000; Beaver River Power Co., $500,000; Idaho Power and Light Co., $500,000; Great Shoshone & Twin Falls Water Power Co., $2,230,000; Southern Idaho Water Power Co., $1,900,000; Idaho Consolidated Power Co., $300,000; American Falls Power, Light and Water Co., $150,000; Pocatello Power and Irrigation Co., $50,000.

Corrosion About the Power Plant

By H. J. Macintire*

SYNOPSIS—Explains how corrosion attacks the steam and water piping; also describes the corroding action of brine in refrigerating systems, and tells how to minimize corrosion in the plant.

Much corrosion in engineering applications could be prevented if the causes were sufficiently understood. Recently, certain theories, substantiated in part by experiment, have been advanced, and the object of what follows is to explain these ideas of corrosion and its possible prevention, especially in cases of piping used for heating and ventilation and for refrigeration.

The Chemistry of Corrosion

At present all corrosion is accounted for by electrolysis or galvanic action. For example, if zinc and copper are placed in muriatic acid and connected together, there will be an electric current generated and the electro-positive element (zinc, in this case) will in time be dissolved (see Fig. 1). The corroded metal has been found to follow the current, the current being understood to begin with the electro-positive element and to flow through the electrolyte to the negative element. The usual metals are electro-positive in the order given:

+Aluminum, zinc, iron, lead, tin, and copper—

so that zinc is positive to all metals to the right of it in the list, the potential difference being greater with the degree of separation of the metals in the list. It is advisable to amalgamate the zinc with mercury before using, for if the commercial zinc alone were used the impurities present would accelerate the galvanic action. Likewise, two similar metals in an electrolyte and connected will cause a current to flow, but the direction of flow will depend on the internal structure of the metal—on the relative density of the material, the impurities and whether the metal is subject to stress. The character of the mill scale and its degree of segregation is a large factor in the amount of self-corrosion developed.

Self-Corrosion Common

Self-corrosion is the most common of all kinds of oxidation. No commercial metals are pure, and even if they were, they would shortly be brought into contact with foreign materials floating in the air or the electrolyte with which the metal is in contact. A good example of this is buried water pipes which are brought in contact with cinders.[1] The carbon in the cinders and the metal pipe (if the soil is sufficiently damp) induces self-corrosion, as it is an electric battery ready for operation. In the case of steam condenser tubes, the average Admiralty tube (70 copper, 29 zinc, 1 tin) has a life of six years, although this varies with the locality. Here we have the zinc dezincified, especially in the close-grained metal, as the zinc is electro-positive. It would seem as if it would be best to use pure copper in this case, but pure copper is difficult to obtain, as in the process of manufacture a copper oxide is formed which is electro-negative to copper and the copper would be dissolved when the galvanic action was set up, similarly to the condition with mill scale in steel pipe.

In the case of ordinary steel pipe, mill scale is always present, and this likewise is electro-negative to the iron. If this scale is evenly distributed, as in spellerized steel, the self-corrosion on its account will be slight; but if it is segregated, then local electrolysis and pitting of the material will result (see Fig. 2).

It has been noted, undoubtedly, that after corrosion begins it will continue very rapidly unless arrested. The explanation of this is that iron oxides are good conductors and are electro-negative with respect to the iron.[2] Self-corrosion is set up and is likely here to be very local and to carry on its action almost perpendicular to the surface, and the result is pitting which may continue until a hole is made through the pipe, although the remainder of the pipe may be in good condition. Self-corrosion (contrary to electrolysis) depends on the presence of oxygen for its continuance. A steam boiler may be laid up indefinitely by completely filling it with water. Some corrosion may occur due to the oxygen in the water, but this will stop as soon as the oxygen content is reduced to about 1c.c. per liter, unless the boiler is subject to outside corroding influences. A brine line or hot-water heating system will

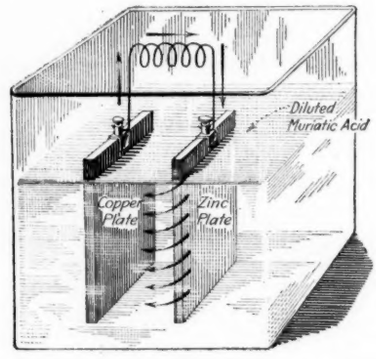


FIG. 1. ILLUSTRATING ELECTROLYSIS

not corrode by self-induced electrolysis unless air is allowed to enter.[3] This is the case with the makeup water pipe of the latter, due to the air brought in with the makeup water. Here the explanation is that as the current is formed, owing to the galvanic action, a film of hydrogen collects at the cathode points, which are poor conductors, and practically polarizes the circuit. This film diffuses slowly, and a counter electromotive force is thereby set up, the net result being that corrosion is arrested. If oxygen is present, it reacts with the hydrogen and depolarizes the cathode points, and corrosion will continue according to Faraday's laws, which have shown that about 20 lb. of iron per ampere per year is liberated. From this a simple calculation will quickly show the short time required to corrode a $\frac{1}{16}$-in. hole in a $1\frac{1}{2}$-in. pipe, even when the current is as small as a milli-ampere. The action of oxygen is also to unite with the ferrous

*Professor of mechanical engineering, Washington University.

[1]Bureau of Standards Bulletin No. 52.

[2]Bureau of Standards Bulletin No. 25.

[3]Trans. American Society of Heating and Ventilating Engineers, 1916. Paper by F. N. Speller.

oxide and to form the reddish-brown ferric oxide which is familiar to all as rust.

A large amount of corrosion has its explanation in stray power, always found in districts that have rail returns from railroad motors.[4] The same thing may be found in industrial plants or buildings that have direct current and the motors or wiring not perfectly insulated. A ground on the line means that some current is making its return by means of an independent path to the generator. Trouble may be found wherever this stray power is detected. It may use the reinforcement of concrete buildings or metal pipes, and where it leaves the metal, corrosion is likely to be found. The corrosion may be bad enough in the former case to burst the concrete, owing to the iron oxide occupying more space than the metal itself. With stray power oxygen is not a necessary adjunct, but will be found to be as effective in its corrosive action with any amount of air present.

And now how about the prevention of corrosion? The cure must occur at the source. In the case of stray current

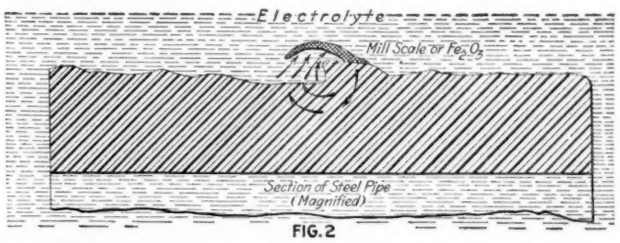


FIG. 2

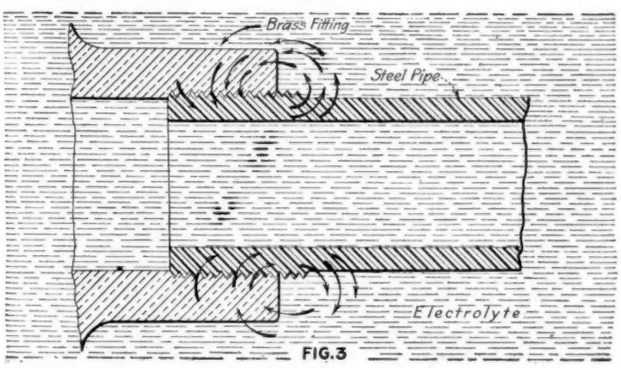


FIG. 3

FIGS. 2 AND 3. CORROSION IN PIPE AND FITTINGS

the trouble must be searched for with a delicate meter, and corrected. If the corrosion is due to a ground, the faulty circuit must be found by opening each circuit in turn and noticing the ground lamps on the switchboard. An extension light resting on a gas or water pump may be the only trouble. If the stray power is of outside origin little can be done other than short-circuiting the building with a heavy copper wire. The reader will remember that Faraday's law does not state a minimum amount of current necessary for corrosion. In fact, it is undoubtedly true that these small currents start the corrosion, which is greatly accelerated by self-corrosion, especially if oxygen is present.

Self-corrosion may be carried on by the use of dissimilar metals,[5] the use of brass, copper and zinc in steel pipe lines, especially in the case of refrigeration by means of brine. If brass valves or other fittings are used with steel or galvanized iron, the steel or iron will be destroyed, except possibly where the fittings are made up with a heavy coat of shellac as an insulator. As a rule, for brine lines, galvanized iron should not be used, or zinc in any other form, as for example, in the case of the venturi meter. Galvanized iron cans when used in the can ice plant may be protected themselves, but some other part, the steel tank or the expansion coils, will have to suffer. Zinc should have no part in a system where an electrolyte such as brine is also present.

Experiments have shown the importance of oxygen in solution in the liquid. The temperature of the liquid has a large amount of influence on its ability to carry gases in solution, as can be seen from the following table of saturated solutions of water and oxygen.[6]

Deg. F.		
32	10.19	Cu.ft. at 29.92 in. of mercury per 1,000 cu. ft. of water.
50	7.87	
68	6.38	
86	5.26	

With heavier pressures, however, the amount of oxygen at saturation is considerably greater, and vice versa. If the brine for refrigeration or hot water for heating is self-contained, fills the pipes completely and does not have a chance to come in contact with the atmosphere, such air as it contained at first will soon be exhausted and corrosion, due to galvanic action, will stop. Faulty design or operation so that air pockets are present or that air is sucked into the system will make it possible for the action to continue; once started, the action is very rapid if conditions are suitable. In refrigerating work air may get into the brine in the can ice tank during the operation of pulling the ice. In some exceptional cases, also where brine is used to cool air by direct contact, excessive air will be found in solution and corrosion from this cause will be at a maximum.[7] The same would be true of secondary heaters and boilers of steam-power plants, where the makeup water is continually bringing in a new supply of air, except that the water usually has scale-forming material which tends to give a protecting covering to the surfaces. In general a velocity of three feet per second or less will allow scale to form in the pipe. Velocity is, therefore, important in corrosion prevention.

To resume, corrosion is due to many factors—no one combination probably being exactly like another. Frequently the action is started by stray currents and is continued by self-corrosion or galvanic action. In pipe lines dissimilar material must be avoided, but if used, should be insulated as much as possible from its neighbors. Avoid zinc in steel pipe lines. If direct current is used, remove all grounds from the system. Remember that the current does not have to be large to cause electrolysis.

Negligent Operation of Gas Engine—The Louisiana Supreme Court has dismissed a suit brought to recover damages for serious injury sustained by an operator of a gas engine used in pumping oil wells, while throwing in the clutch of the engine. (Murphy vs. Standard Oil Co., 73 Southern Reporter, 678). The evidence tended to show that plaintiff attempted to use a long piece of 2-in. iron pipe to poke or bump the clutch of the engine while the engine was running, and that one end of the pipe, going too far, had slipped into the spider, causing the other end to whip around, striking plaintiff with such force as to frightfully disfigure his face. "If this was the manner of the accident," says the court, "the defendant company is not liable, for the responsibility then rests with plaintiff himself for having adopted unnecessarily this admittedly dangerous method of putting on the clutch."

[4]Trans. American Society of Refrigerating Engineers, 1916.
[5]Trans. American Society of Refrigerating Engineers, 1916. Discussion by F. L. Fairbanks.
[6]Winkler, 1904.
[7]Eng. Soc. of Western Penn., 1912. Paper by Bruce Walter.

Chart for Determining Power Costs

By H. Bailey

SYNOPSIS—An explanation of a chart for determining the cost of power for street lighting at different rates and lighting schedules. The chart can also be used by the operator to determine the lighting and extinguishing time for each day during the year.

Municipal street lighting in these days is a source of considerable revenue to central stations. In the early days the old-fashioned arc lamp, requiring a constant current of 6.6 amp., was the standard street-lighting unit, but this is rapidly being replaced by the more efficient gas-filled tungsten incandescent lamp. The old arc lamp, as originally made, had its two electrodes exposed to the atmosphere, and consequently they burned away very rapidly, requiring renewal daily. Later the inclosed arc lamp made its appearance, giving better illumination and needing less attention for renewals. The greatest advance, however, was the introduction of the highly efficient gas-filled incandescent lamp, requiring practically no attention, except occasional cleaning and perhaps renewal at remote intervals.

The old-fashioned arc lamp was built mainly to operate on a constant current of 6.6 amp. In some instances 5.5 amp. were used; in others 7.7 amp.; but the majority of arc-lighting circuits were operated at 6.6 amp. When it was found that the new gas-filled incandescent lamp could be made in such large sizes as 250, 400 and 600 cp., manufacturers naturally designed them to operate on existing arc circuits of 6.6 amp. Arc lamps and incandescent lamps were tried on the same circuits simultaneously, but results were unsatisfactory as the constant flickering of the arc was noticeable in the incandescent lamps.

Gas-Filled Lamps Replacing Arc Lamps

As a result the arc lamp is rapidly being replaced by the gas-filled incandescent lamp, and central-station managers are frequently called upon to quote prices to municipalities for incandescent street-lighting units. There is considerable agitation nowadays for what is known as "white way" street lighting, and the public in large and small towns are anxious to have their main thoroughfares brilliantly illuminated by means of the new gas-filled incandescent lamp, of high candlepower, mounted on ornamental posts.

The accompanying chart furnishes a means for rapidly calculating prices for street, advertising or sign lighting. By its use the central-station operator can also read with sufficient accuracy the time for lighting and extinguishing the lamps each day throughout the year as the time of daylight lengthens or shortens with the seasons.

Regular street-lighting hours generally run either from dusk to dawn or from dusk to midnight or 1 a.m., as selected by the municipal authorities. In some instances a moonlight schedule is used, but the public is becoming dissatisfied with this system and it is rapidly being superseded by the dusk-to-dawn or dusk-to-midnight schedule. Sign and advertising lighting generally runs from dusk to 11 p.m., 12 p.m. or 1 a.m.

Referring to the chart, it will be noticed that the lower horizontal scale indicates the wattage of the lamp. It will also be seen that at certain points heavy vertical risers are shown. These risers indicate the wattage required by 6.6-amp. incandescent street lamps of standard candlepower as manufactured by one of the most prominent lamp manufacturers. In the case of the 15- and 20-amp. lamps, the wattage assumed is based on a compensator efficiency of 93 per cent., and attention is called to the greater efficiency of these high-amperage lamps. Of two lamps of equal candlepower, the high-amperage lamp shows the greater efficiency even though handicapped with the losses in the compensator. However, a lamp of any wattage between 40 and 600 can be calculated on the chart.

How To Use the Chart

The diagonal full lines represent the price per kilowatt-hour which the central station must receive in order to profitably handle the street-lighting contract. The dotted diagonal lines represent the number of lighting hours per year based on the different schedules shown on the chart.

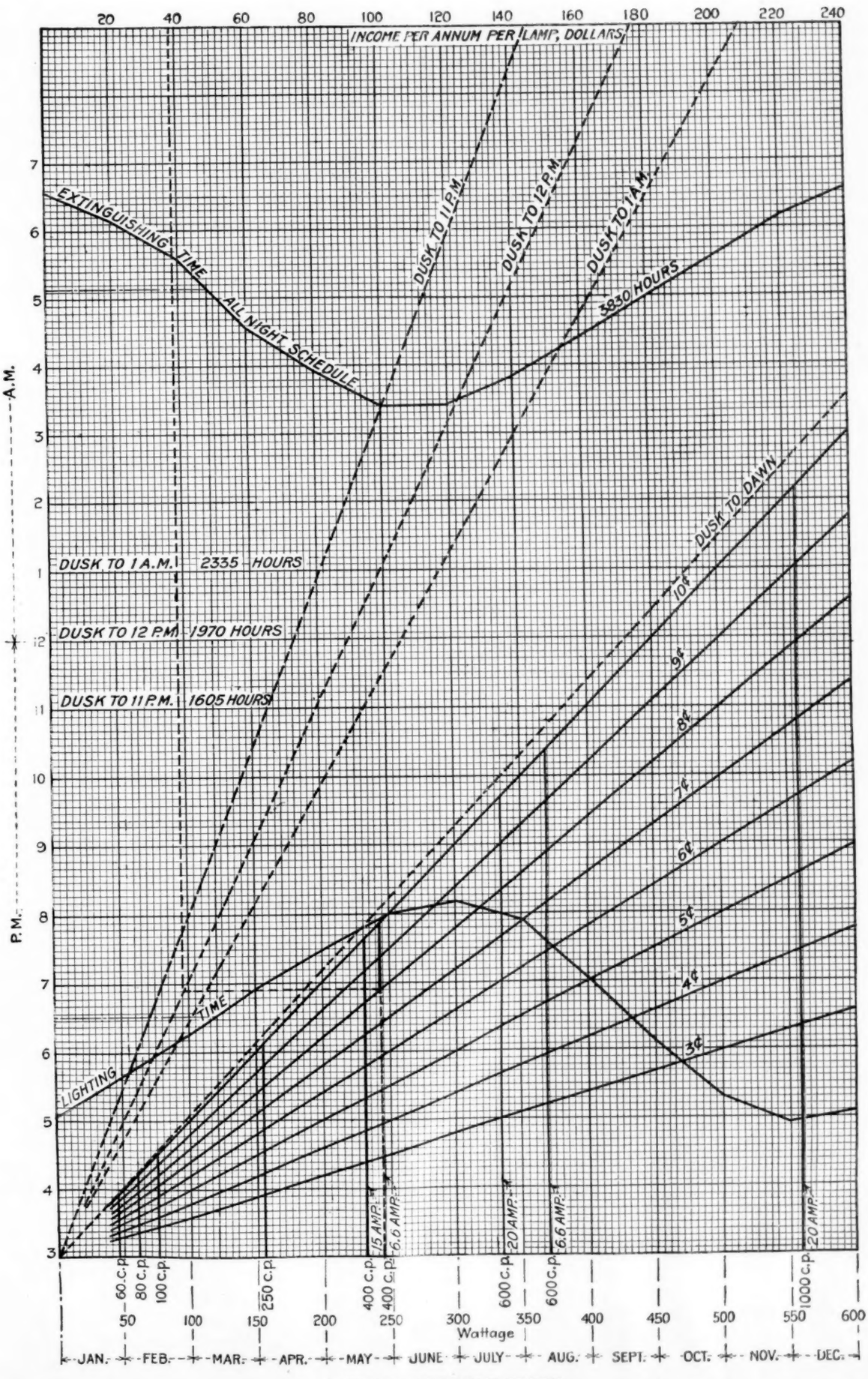
The user, therefore, first starts with the wattage of the lamp selected. For example, this may be a 400-cp. 6.6-amp. lamp, as shown on the chart. Knowing the rate that he should receive—say 8c. per kw.-hr.—to cover generation, transmission and other costs, he then follows up the vertical wattage line until it intersects the 8c. line. If the lighting schedule desired is from dusk to 12 p.m., he follows horizontally to intersect the dotted diagonal representing this schedule. From the latter intersection he rises vertically to the upper scale and reads the price per annum per lamp; namely, $38.50.

Naturally, the process can be reversed. Given the price per annum per lamp, one can drop a vertical to intersect the lighting schedule, thence horizontally to intersect the lamp wattage and obtain the corresponding rate per kilowatt-hour.

The Lighting Schedule Used in the Chart

The lighting schedule is that of the National Electric Light Association, known as the "Northern Schedule," is based on the local mean time and is correct within a few minutes for the states of Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, Michigan, Wisconsin, Minnesota, North and South Dakota, Montana, Wyoming, Idaho, Oregon, Washington and southern Canada.

In reading the lighting and extinguishing curves, each vertical space represents six minutes, while each horizontal space represents three days until 10 spaces have elapsed, when another month begins. For example, if it is desired to know the lighting and extinguishing time on Mar. 12, count four spaces to the right in the March section at the bottom of the chart, then follow up the vertical line to the lighting-time and extinguishing-time curves, from these intersections follow on the horizontal to the left as indicated by the dot-and-dash line, when it will be found that the lights should be turned on at about 6:33 p.m. and extinguished at about 5:08 a.m.



LIGHTING SCHEDULE CHART

Operating Mechanical Stokers—IV

By Warren O. Rogers

SYNOPSIS—The operation of front- and side-gravity-feed stokers is dealt with. With minor exceptions the instructions for one design front-feed stoker apply to the others. The same also applies to the side-feed type of stokers, which are similar to one another in construction and operation.

As the operation of no two boiler plants is exactly alike, it is necessary for the fireman to become familiar with his stoker and with the requirements. To obtain the best results in the operation of any stoker, intelligence must be exercised. Among the successful stokers there is the class of front-feed with inclined grates. Their

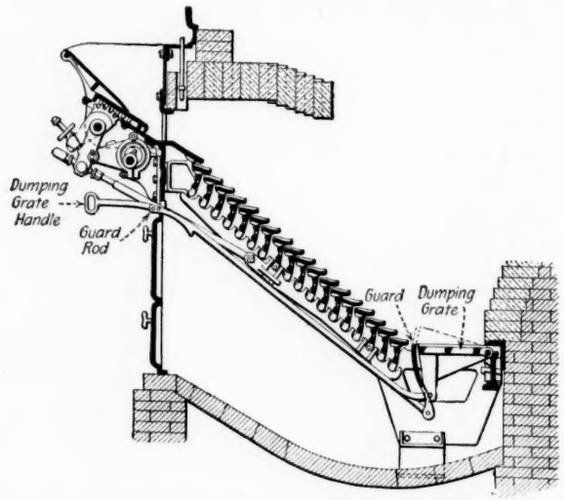


FIG. 1. SECTION THROUGH RONEY FRONT-FEED STOKER

operations are similar, and in the main the method of handling one stoker of this type will practically apply to the others.

In all types of overfeed stokers the coal is pushed in at the top of the sloping grates and coked by the aid of firebrick arches. The coal is moved from the top to the bottom of the grates by various motions of the bars, aided by gravity. Clinker collects at the bottom and is crushed or dumped according to the design of the stoker.

All coking is confined to the top of the furnace, and as green coal packs tightly, making it impossible for air to get through it under slight differences in pressure, air for burning the volatile matter is supplied from openings in the arch or from excess air admitted through the lower part of the grate.

Coking leaves the coal in a somewhat porous state, which allows plenty of excess air to move through the mass of fuel. An evidence of this will be the smoky red flame that passes between the boiler tubes over the coking zone, changing to yellow and blue and then to a clear and almost flameless fire at the dumping end of the grate.

Trouble may arise from fusion of ashes in contact with the side walls and bridge-walls of furnaces and results in expensive repairs and the cutting out of the boiler while they are being made. Clinkering to an excessive degree can be prevented by slicing the fires and dumping the ashes before they have been left for such long periods that they fuse and become so large as to be difficult to dislodge. If the ashes are not dumped frequently, the fuel will be all consumed, whereas if dumping is done at short intervals the combustible is not all burned out and such as is not consumed is dumped into the ashpit. Watching the results obtained with the grade of coal used will govern the fireman as to the length of time between dumpings. Some trouble may be experienced with the crushing rolls of V-type stokers from adhering clinkers or the failure to crush large ones. When burning coal that produces such clinkers, barring will be necessary. Operating the stokers at their proper capacity as rated in pounds of fuel per square foot of grate area, there will be but little trouble from clinkers.

To start a fire, cover the grates with coal and then light a wood fire on top of the fuel and keep the damper partly open until the fuel has become ignited, after which open the damper wide and feed the stoker slowly until the furnace arch has become thoroughly heated.

During operation the grates should be kept covered with fuel, the thickness depending upon the load being carried. As with any other grate, the inrush of cold air through the fuel bed will decrease the efficiency of the furnace, but this can be prevented by regulating the fuel feed.

The method of cleaning the fires differs to some extent. With the Roney stoker (Fig. 1) the guard grates are first lifted by pulling on the guard rods. This movement breaks the clinkers free from the grates, and they readily drop into the ashpit when the dumping grates are

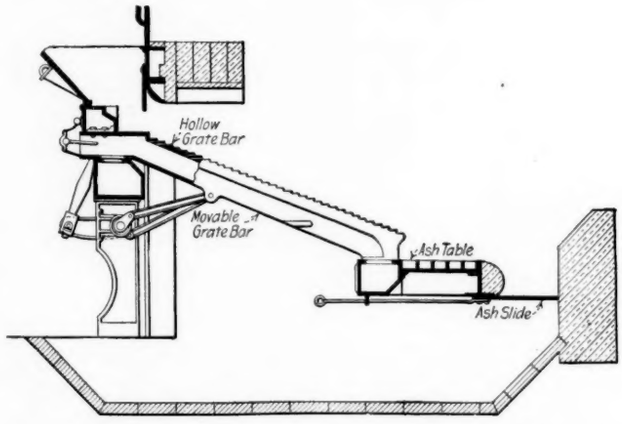


FIG. 2. SHOWING ASH TABLE OF WILKINSON STOKER

tilted. The guard grates should not be lowered until the dumping grates have been returned to their closed position, otherwise live coals from the lower grates will drop into the ashpit.

Frequently a clinker will not go past the dumping grates, in which case break it loose and pull it out with a hook instead of slamming the dumping grates open and shut in an attempt to free the clinker. If this is done, burning coal will dump into the ashpit, at the same time uncovering the lower grates. Having dumped the ashes, close the dumping grates and then return the

guard grates to their normal position. There will be no necessity for poking the fires to cover the lower end of the grates with fuel.

As the length of the fire can be regulated by the speed of the stokers, there is no need to work the fire through the side inspection door, and this generally causes a mass of coal to slide down the grates. Poking at the front

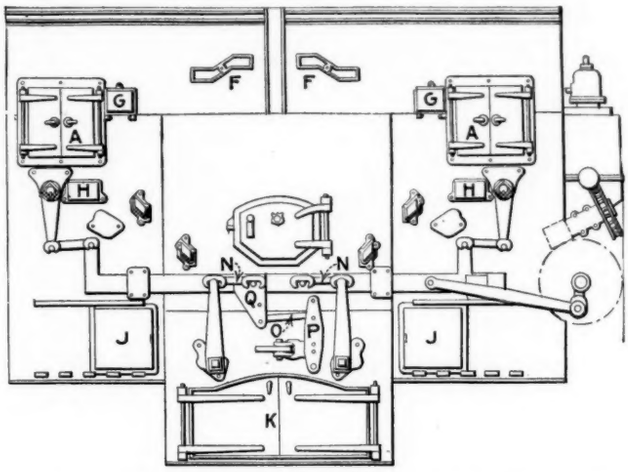


FIG. 3. FRONT OF FURNACE EQUIPPED WITH SIDE-FEED STOKER

of the grates has a tendency to cause a mass of live coals to slide toward the bottom, thus necessitating the dumping of a large amount of green coal on the upper portion of the grates.

For increased demands for steam, speed up the stoker. With high steam pressure, slow down the stoker rather than close the ashpit doors. If the steam pressure still increases stop the stoker feed and close the damper after the volatile matter has been burned off. In the case of the Wilkinson stoker (Fig. 2) the ashes and clinker are deposited on an ash table and are discharged into the ashpit by pulling an ash slide. The Wetzel stoker (Fig. 4) has a dumping grate, the pushing down of which dumps the ashes and clinkers into the ashpit. If the feeding of coal onto the grates is either too fast or too slow, the speed of the pushers can be regulated for the service required by making its travel long or short, as the case may be, by adjusting the hand-wheels. The shaking of the main grate can be adjusted slow or fast, according to the amount of ash in the coal, by adjusting the lost motion on the eccentric rod that produces the slaking movement. In handling the side overfeed stokers, of which the Murphy and the Detroit are examples, the method of operation is similar and the instructions pertaining to one will apply to the other.

In Fig. 3 is shown a front view of one of these stokers. Coal is shoveled through the magazine door *A*, or it can be delivered into the tops of the magazines through coal chutes. From the magazines *B*, Fig. 5, the coal is pushed out on the coking plate *C* by the reciprocating pusher boxes *D*. The coal in traveling from the coking plate *C* to the upper end of the grates is coked and the released hydrocarbon gases mix with the heated air that is admitted through the tuyere openings *E*. The amount of air admitted is regulated by the dampers in the furnace front. The burning coke moves slowly down the inclined grates *I*, Fig. 5. The air supply for combustion is then taken in through the stoker fronts at several points, and air admitted through the dampers *F*, Fig. 3, goes to spaces between the furnace arches, where it becomes heated and then passes through the arch boxes. Air admitted through the upper hoods *G*, which have sliding dampers, passes through the arch boxes and out through the tuyere openings. Air admitted through the lower hoods *H* passes through the coking plates *C* and then up through the rear chamber into the arch boxes and then out over the fire. Two doors *J* are for admitting air under the grates and for the removal of fine coal siftings that may fall through the grates. Doors *K* are for admitting air under the grates and for the removal of ashes.

Clinkers are taken care of by a crusher that forms the lower and center part of the furnace. The toothed shafts or the disks *L*, Fig. 5, as the case may be, are to grind the clinkers and deposit them in the ashpit. The exhaust pipe from the stoker engine connects with perforated pipes *M* that run below or along the upper side of the grate supports, and they are so placed that the steam is forced in between the clinker grinder and between the grates at their lower ends. The steam softens the clinker, making it easier on the crusher.

As in the case of any new stoker and boiler setting, a slow fire should be run for a few days, not less than 24

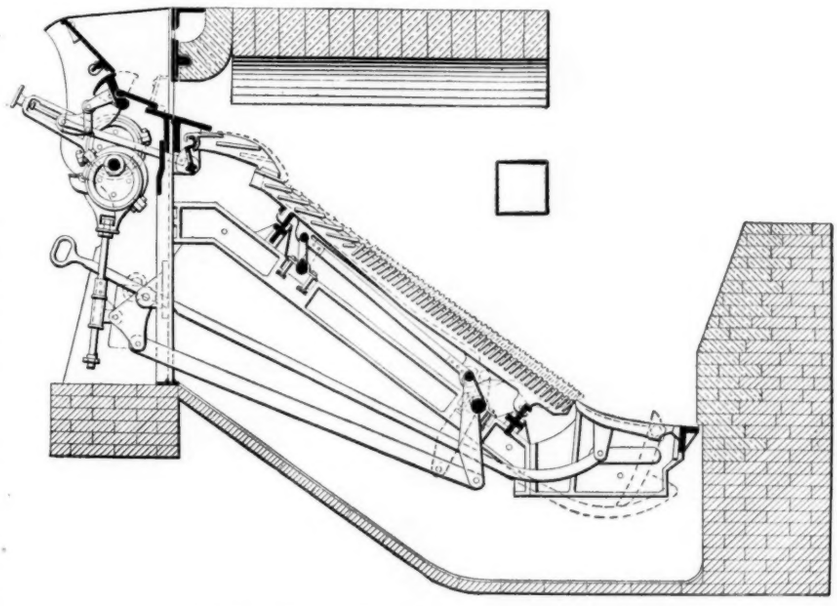


FIG. 4. DETAILS OF THE WETZEL STOKER

hours in any event, so that the arches and brickwork may be thoroughly dried out before being brought up to the everyday working temperature.

In starting a fire in these stokers, first cover the crusher and lower ends of the grates with wood to prevent the coal from running through them. Then fill the magazines with coal and by means of a hand socket wrench operate the pusher box so that coal will be pushed out

until the grates are covered on both sides. Kindling can then be put in through the fire-door near the front of the grates and the fire started. The grates can be kept covered by working the coal out by hand until there is sufficient steam pressure to operate the stoker engine.

When starting the stoker with a new fire, and the feeding of coal is accomplished by hand, all moving parts should be disconnected from the reciprocating driving bar by removing the links. Before putting on the links the stoker should be operated by hand to be sure that the grates, pusher boxes and clinker crusher all operate freely and at full strokes.

When the steam pressure is sufficient to operate the stoker engine, the links driving the pusher boxes should first be connected and then the grates. The clinker crusher should not be connected until they are covered with ashes. If possible the engine should be kept running after steam is up and the grates kept in motion. If it is necessary to stop the engine, remove the rocker-bar links *N*, Fig. 3, and see that the vibrating grates are down out of the fire, so as to prevent burning them.

As to the thickness of the fire to be carried, that depends on the nature of the coal and the draft to be carried and should be whatever the operator finds the best. A fire of about three to four inches in thickness usually gives the best results. Precautions should be taken not to allow bare spots on the grates or to let the fires become too thick. If the coal is feeding too fast, slow down the stoker engine. If the fire is too thick on one side of the grate, remove the link from the pusher-shaft arm for a

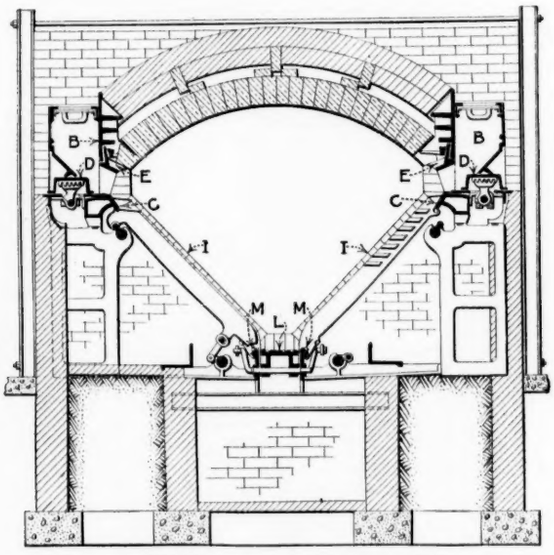


FIG. 5. FRONT ELEVATION THROUGH SIDE OVERFEED STOKER

few minutes; if the fire is too thin on one side of the grates, use the hand socket wrench and push a sufficient amount of coal out on the grate to even up both sides.

In the front and at the side of each furnace capped roust holes are provided so that in case of a sudden demand for steam a roust bar can be used through them and the fire broken up. If a hole in the fire or a bare spot appears on the grates, the bar is used through the holes to remedy the trouble. The roust bar should be pushed into the furnace with the hook against the grates. Pull it out through the coal with the hook turned at right angles with the grates. The fire near the top, where it is coking, should never be poked or disturbed. Under no circumstances should the grates be covered through the fire-doors, as this will reduce the efficiency of the furnace; cold air also has a damaging effect on the brickwork.

In case the fire becomes dirty at the bottom of the grates, the hand lever can be used to break up the clinker and by giving the clinker crusher a few turns the fire will be cleaned. Although there are several speeds for the crusher, the proper one depends upon the amount of clinker formed in burning the coal. With the link *O*, Fig. 3 (Detroit stoker), on the upper pins in the arm *P* and the driving plate *Q*, and the pin at the lower end of the arm *P* in its lower hole, the least motion will be obtained: with the link on the lower pins in the arm *P* and the driving plate *Q*, and the lower pin of the arm *P* in its upper hole, the maximum motion will be had.

Where the stoker is running continuously, the magazines should be kept full of coal so that no fire can be seen through the magazine doors. If coal is thrown through the magazine doors, the back end should be filled and the coal in the front end left five or six inches from the top. If it is difficult to throw the coal to the back end of the magazines with a shovel, a hoe can be used and the coal pushed back with it. To obtain the best results, the magazines should be evenly filled so as to insure an even distribution of coal on the grates. When coal is fed from overhead, the coal slide should be shut from time to time and the magazines allowed to become partly empty so as to make sure that an even feed is being obtained.

When a stoker is to be shut down, gage the supply of coal so that the magazines will be empty and the fire on the grates well burned down. Should a sudden stop find the magazines filled with coal, it should be prevented from catching fire by moving the pusher boxes occasionally until the magazines are empty, or the coal can be pulled out through the magazine doors.

To bank a fire, first clean it and remove all the clinkers from the stoker and then pull the coke to the front end of the grates. Then throw fine coal in through the fire-door, covering the live coke with coal. Close all the doors on the front of the stoker and nearly close the breeching damper. When banking a fire, always be sure that there is no coal in the magazines.

To start up from a banked fire, spread the coke along the bottom of the grates and cover them with coal through the magazines and open the draft doors and dampers, leaving the air-flue opening *G*, Fig. 3, in the front of the stoker partly closed.

To avoid burning the grates, ashes should never be allowed to fill up the ashpit. Such an accumulation also cuts down the draft and prevents air from passing under the grates and crusher.

Naturally, all bearing and working parts should be kept well oiled and greased and fine coal or grit should not be allowed to come in contact with any of the worms or gears, as it would be likely to cause cutting.

[In article No. 2 of this series, May 22, Fig. 4 of No. 3 article was inadvertently published as Fig. 2. It showed a cross-section through a single-retort type E stoker (Combustion Engineering Corporation), whereas a cross-section through a single-retort Jones stoker (Under-Feed Stoker Company of America) should have appeared.—Editor.]

Results with Superheated Steam

By B. N. Broido

SYNOPSIS—A statement of results obtained by the use of superheaters in some existing plants. The cost of installation was relatively greater than if included in the original construction.

The advantages of superheating steam are now well recognized, and many new plants are being equipped with superheaters. Considerable gain can also be made in numerous existing plants operated with saturated steam, by installing superheaters and changing the piping and engines for the use of superheated steam. During his experience in Germany the writer changed over a number of plants, of which the following are examples.

The management of a large textile concern realized that it was necessary to lower the power cost, and it was decided as one means to this end to take advantage of the use of superheated steam. The boiler plant consisted of five so-called double boilers, a combination of fire-flue and return-tubular boilers, as shown in Fig. 1, each of about 2400 sq.ft. heating surface operated at 180 lb. gage pressure. Each boiler was equipped with a superheater of the uni- and counter-flow type of about 600 sq.ft. heating surface, designed to superheat the steam when operated at rated capacity (45 lb. per sq.ft.) to 716 deg. F. or 336 deg. superheat.

The steam was for use in two engines, one triple- and one double-expansion, both having poppet valves. Both engines were fitted with new high-pressure cylinders of a type designed for steam at 350 deg. F. superheat, and the piping between the boilers and engines was entirely changed and the fittings and valves used were of cast steel

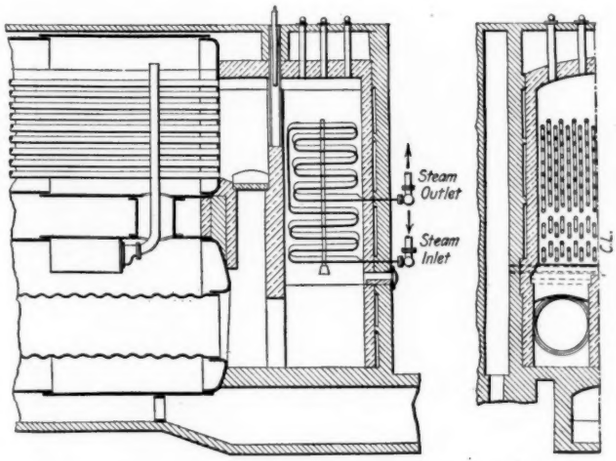


FIG. 1. SUPERHEATER AND COMBINATION BOILER UNIT

or of special cast iron for high temperature, the same as that in the high-pressure cylinders.

The new piping was much smaller than the old, which to the large engine was previously 12 in., while to the new it is only 9 in.; and to the smaller engine, instead of 8, is only 6 in. The old piping could be used for other purposes, which offset considerably the cost of the new installation. The temperature in the flue chamber, where the superheater was located between the lower and upper drums, in this type of boilers is very high, as the heating surface in the lower drum is only a small percentage of the total; therefore the heating surface of the superheater was small. On the other hand, the high temperature required careful design, for which the uni- and counter-flow type is best suited.

It is a well-known fact that the transferring of heat from one fluid to the other through metallic walls is much more rapid when the flow is in opposite directions. This principle cannot always be applied to superheaters, for if the steam flows in the opposite direction to the flue gas, it means bringing the hottest gases and the hottest steam together, as shown in Fig. 2, which causes the superheater tubes at this point to become overheated and burn out. To overcome this difficulty the uni- and counter-flow superheater is used. The saturated steam enters where the gas is at the highest temperature, cooling the pipes from the inside, and flows part of the way in the same direction

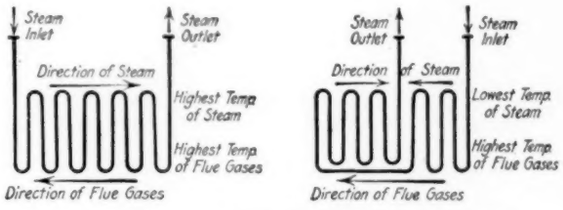


FIG. 2. TYPES OF SUPERHEATERS USED

as the gases to a certain point, where the temperature of the gas has become lower; the steam then changes its direction and flows the opposite way, taking full advantage of the counter-flow system.

Tests made previous to and directly after the superheater was installed are shown in the table.

RESULTS OF TESTS MADE BEFORE AND AFTER INSTALLING THE SUPERHEATER

Date of test	Feb. 19, 1914	Mar. 23, 1914
Duration, hours	5	6
Number of boilers in operation	4	3
Kind of coal	Brown-coal of Bavaria	
Calorific value per lb. as fired, B.t.u.	8,162	8,233
Steam pressure by gage, lb.	170.2	169.8
Force of draft at damper, in.	0.78	0.84
Temperature of feed water, deg. F.	204	208
Temperature of steam, deg. F.	375.4	663
Superheat, deg. F.	0	288
Water evaporated per hour, lb.	38,808	30,052
B.t.u. added per lb. of water	1,025	1,172.8
Factor of evaporation	1.06	1.21
Equivalent evaporation per hour, "from and at," lb.	41,137	36,363
Coal burned per hour, lb.	7,240	6,194
Water evaporated per lb. of coal, lb.	5.36	4.85
Equivalent evaporation "from and at" per lb., coal, lb.	5.68	5.87
Boiler horsepower developed	1,192	1,059.7
Percentage of rated capacity	124.2	147
Over-all efficiency of boiler	67.4	69.1
Steam consumption of triple-expansion engine, lb. per hour	26,471	20,056
Steam temperature—inlet, deg. F.	374	633
Superheat, deg. F.	.....	259
Horsepower developed	2,038	2,045
Steam per hp.-hr.	12.99	9.8
Coal (8,200 B.t.u. per lb.), per hp.-hr.	2.44	2.01
Steam consumption of compound engine, lb. per hour	12,337	9,996
Steam temperature-inlet, deg. F.	374	627
Superheat, deg. F.	.....	253
Horsepower developed	915.4	980
Steam per hp.-hr.	13.48	10.2
Coal (8,200 B.t.u. per lb.) per hp.-hr.	2.506	2.102

The cost of the new installation was: Two high-pressure cylinders, $5600; four superheaters 600 sq.ft. each, including setting, $3900; piping, including covering, $3700; total, $13,200. The old piping used for other purposes was estimated at $1200, reducing the total cost of the new installation to $12,000.

The triple-expansion engine was run 24 hours per day about 350 days per year; the compound engine was used only as an auxiliary and was run about 12 hours a day in winter and 8 hours in summer, averaging 10 hours daily for 300 days in the year.

The annual saving can be figured as follows: Assuming an average load of 2040 hp. for the triple-expansion engine and 950 hp. for the compound engine, the coal costing $2.15 a ton (2240 lb.) on the grate,

$$(2.44 - 2.01)2040 = 877.2 \text{ lb. of coal per hour}$$

$$350 \text{ days at } 24 \text{ hours} = 8400 \text{ hours per year}$$

$$877.2 \times 8400 = 7{,}368{,}480 \text{ lb. of coal per year}$$

$$\frac{7{,}368{,}480}{2240} = 3289.5 \text{ tons}$$

for the triple expansion engine, and for the compound engine in the same manner gives 514 tons. Total saving on coal: 3289.5 + 514 = 3803.5 tons; 3803.5 × $2.15 = $8177.

The charges against the installation were: Interest 5 per cent., $600; taxes and insurance 4½ per cent., $540; depreciation for high pressure cylinders and piping 8 per cent., $744; depreciation for superheater 12 per cent., $468; total charge per year, $2354.

The clear profit secured through the use of superheated steam was $8177 — $2352 = $5825 per year, netting about 48.5 per cent. of the investment.

When for any reason superheaters cannot be installed with the boilers, an independent one with its own furnace can effect considerable saving. A steel-manufacturing concern in the industrial district of Dortmund, Germany, had ten water-tube boilers of about 2800 sq.ft. heating surface each. Between the drums and tubes

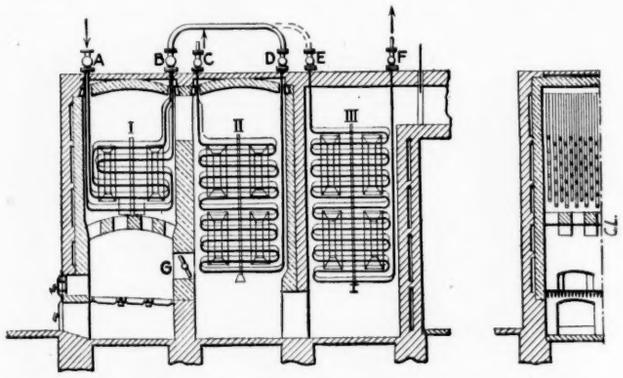


FIG. 3. INDEPENDENTLY FIRED SUPERHEATER PLANT

there was very little space, not enough to accommodate a superheater of sufficient size. The steam was used for different purposes and the piping was very complicated, which would entail considerable expense to change over to superheated steam.

An independent superheater was installed to superheat the steam for one turbine of 2500 hp. and one 1400-hp. reciprocating engine. The turbine was originally built to use steam of 200 deg. F. superheat. The engine was designed for saturated steam, so a new high-pressure cylinder for steam at 300 deg. F. superheat was put in place of the old one. The superheater is shown in Fig. 3 and is remarkable because it furnishes steam for the engines with different degrees of superheat without mixing superheated steam with saturated, as is usually done in such cases. Steam for both engines enters the header *A* and flows through section I of superheater, where it becomes superheated about 100 deg. F. to header *B*. From here the steam divides—one part passes through section III and becomes further superheated to 230 deg. F. and goes to the turbine. The other part flows through section II to the engine with 330 deg. F. of superheat. By the use of damper *G* it is possible to maintain the desired temperature in each part.

The cost of the new installation was: Superheater, $2400; setting and erecting, $980; new piping, $460; new high-pressure cylinder, $2800; total, $6640. The cost of coal delivered to the boiler house was $2.90 per ton (2240 lb.). The tests showed that after the superheater was installed, with the same load a saving of 10,870 lb. of steam per hour could be made, and the new installation paid for itself in less than one year.

Commutator Slotting

By M. A. Walker

In slotting a commutator, it matters not what size it is nor the voltage, the only factor requiring attention being that of the peripheral speed. If this is high a slotted commutator can be operated successfully, but if the peripheral speed is rather slow care should be taken that it is not so low that the centrifugal force will be insufficient to throw out any foreign matter that may lodge between the segments and cause sparking and short-circuits.

While undercutting should not be done on slow-speed machines, there are other conditions where it is practically a necessity. One such case is that where graphite brushes are used. The graphite brush is soft, and if the mica is not cut down, high mica and sparking soon result. Another instance where slotting is necessary is that of the modern high-speed 60-cycle rotary converters. In these machines the proportion of copper to mica in the commutator is very much lower than in small slow-speed equipments, and if the mica is not undercut, commutation, commutator and brushes all suffer.

It has been pointed out that undercutting or slotting of commutators may be done from choice or necessity, and where it should not be done. There is, however, one case where particular care should be taken, and that is in coal mines or similar places where, even though the commutator speed be high, the dirt in the atmosphere is extreme, and here it is a matter of individual judgment.

In cleaning commutators that are slotted, oil should be kept away as a general thing. Oil has a deleterious effect upon mica and, if used too liberally upon a slotted commutator, soon collects in the slots, causing irreparable damage. It also assists in the formation of semiconducting masses which may cause short-circuits, grounds and sparking. Apart from the fact that the slots tend to encourage the collection of dirt, another factor to be considered is that trouble can go on unseen, which in the commutator without undercut mica is always more apparent. Slotted commutators should be blown out with compressed air at regular intervals; once a week will suffice where the surrounding air is clean. The pressure employed for this purpose usually does not exceed 50 lb. per sq.in., and the nozzle should even then not be placed too near the commutator's surface. The slots should be inspected from time to time to make sure that dirt is not collecting or oil attacking the mica insulation.

The Electrical Study Course—Energy, Work and Power

SYNOPSIS—In addition to working out the problem given in the last lesson, energy, work and power are defined, also the mechanical equivalent of heat. It is shown how the equivalent of the mechanical horsepower may be expressed in terms of electrical horsepower.

In Fig. 1 is given the study problem from the previous lesson. The first and only element that we can find is the current I_1, flowing through circuit R_1. In former lessons we learned that it was not necessary to know the total volts and resistance of a circuit to determine the value of the current flowing through it. All that is required is to know the value of a section of the resistance and the volt drop across this section.

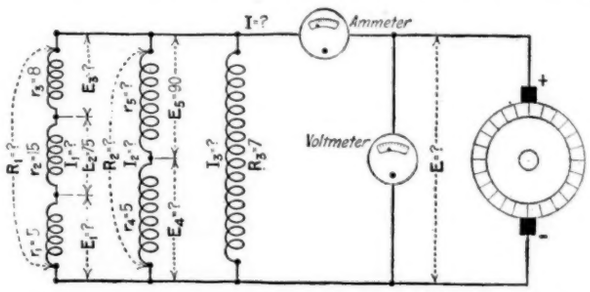


FIG. 1. SHOWS RESISTANCES CONNECTED IN SERIES AND THE CIRCUITS IN PARALLEL

Referring to circuit R_1 there is given the value r_2 and E_2, for the middle section of the resistance. Hence, $I_1 = \frac{E_2}{r_2} = \frac{75}{15} = 5$ amperes. Knowing $I_1 = 5$ amperes, $r_1 = 5$ and $r_3 = 8$, we may find E_1 and E_3 by Ohm's law. $E_1 = r_1 I_1 = 5 \times 5 = 25$ volts, and $E_3 = r_3 I_1 = 8 \times 5 = 40$ volts. The total volts E equals the sum of the volts drop across each section, or $E = E_1 + E_2 + E_3 = 25 + 75 + 40 = 140$ volts. The total resistance R of circuit No. 1 is equal to the sum of the resistances of the three sections, or $R_1 = r_1 + r_2 + r_3 = 5 + 15 + 8 = 28$ ohms.

The solution of this part of the problem may be checked by Ohm's law, $I_1 = \frac{E}{R_1} = \frac{140}{28} = 5$ amp. This checks with the value obtained by $\frac{E_2}{r_2}$.

Considering circuit R_2, 90 volts of the 140 volts total pressure is used up across resistance r_5, then the remainder of the 140 volts must be expended across r_4. Hence E_4, the voltage across r_4, must equal the difference between E and E_5; that is, $E_4 = E - E_5 = 140 - 90 = 50$ volts. $I_2 = \frac{E_4}{r_4} = \frac{50}{5} = 10$ amperes, and $r_5 = \frac{E_5}{I_2} = \frac{90}{10} = 9$ ohms. The total resistance of this circuit, $R_2 = r_4 + r_5 = 5 + 9 = 14$ ohms. We may again check our work by Ohm's law, $R_2 = \frac{E}{I_2} = \frac{140}{10} = 14$ ohms, which is the same as obtained by the other method.

In circuit R_3, $I_3 = \frac{E}{R_3} = \frac{140}{7} = 20$ amperes. The total current $I = I_1 + I_2 + I_3 = 5 + 10 + 20 = 35$ amp. The joint resistance $R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} = \frac{1}{\frac{1}{28} + \frac{1}{14} + \frac{1}{7}} = \frac{1}{\frac{7}{28}} = \frac{28}{7} = 4$ ohms. By Ohm's law $R = \frac{E}{I} = \frac{140}{35} = 4$ ohms; this checks with the joint-resistance method.

For simple parallel circuits the Ohm's-law method of finding the joint resistance is the simplest and the one generally used; but in complex circuits consisting of elements grouped in both parallel and series, it is not possible to apply Ohm's law and the conductance method has to be used.

Energy the Ability for Doing Work

In considering the effort developed by any power-producing device, there are three elements to take into account—energy, work and power. Before considering the energy transmitted by an electric current, it will be necessary to give heed to the significance of these three items. Energy is defined as the ability or capacity for doing work. Air stored under pressure is an example of energy, or the ability to do work. As long as the air is confined in a tank, it cannot do any work. In order that work may be done, it is admitted to the cylinder of a locomotive, where if the proper conditions exist, the energy stored in the air by virtue of the pressure will do the work of driving the locomotive and its load. Again, the air may be admitted to the cylinder of a rock drill and do the work of driving the drill, or it may be used to do the work of operating a multiplicity of different devices.

Steam Under Pressure Possesses Energy

Another example is a spring under tension ready to be released, which may, when released, do the work of moving a body from one position to another. Steam stored under pressure in a boiler possesses energy—the capacity for doing work. Unless the steam is allowed to enter the cylinder of an engine or other devices and put these devices in motion, no work is done. A horse has stored in his muscles the ability or capacity for drawing heavy loads, but as long as he is allowed to remain idle he does not do any work; nevertheless, he possesses the capacity for doing work, or energy that may be converted into work. From the foregoing it is seen that in order that work be done, a force must overcome a resistance; that is, a body must be moved. Thus work is defined as the expending of energy, or we may say work is done when a force overcomes a resistance.

It is not enough that the throttle valve be opened and steam admitted to the cylinder of an engine that work be done, for the engine may be on dead-center or the flywheel blocked so that it cannot turn. In such a case we would have the force of the steam acting upon the pis-

ton, but no work is done because the force has not overcome the resistance offered by the mechanical connection to the piston. All that would occur in the case cited would be a slight increase in the space to be filled with steam. On the other hand, if conditions are such that the engine is put in motion, then work is done, or in other words, the opposition offered by the engine and its load to the force of the steam has been overcome.

Work is expressed as the product of a force in pounds times distance in feet. This may also be expressed as, work = pounds × feet = foot-pounds; the product of a force in pounds × feet being called foot-pounds, and the work done by a force of one pound acting through a distance of one foot is called the unit of work, or one

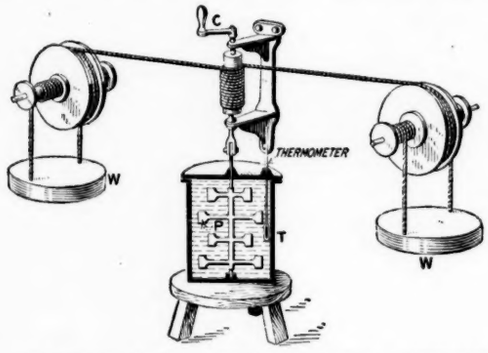


FIG. 2. PRINCIPLE OF APPARATUS FOR DETERMINING THE MECHANICAL EQUIVALENT OF HEAT

foot-pound. Expressing this in another way, one foot-pound is the work necessary to raise one pound one foot.

The simple statement that 1000 lb. has been raised 50 ft.—that is, 50,000 ft.-lb. of work has been done—does not give any idea how hard the individual or device worked in transferring the 1000 lb. from one position to the other. For example, suppose the weight was 10 bags of cement, of 100 lb. each, and a workman carried them up a ladder to a floor 50 ft. from the ground. The knowledge that the task had been performed does not indicate how hard the man worked in performing the work. He may have done the job in an hour, two hours or ten hours; each period would represent a different rate of doing the work. This is where power fits in. Power is the rate of doing work, or in other words the rate of expending energy and is equal to the work divided by time. Thus power $= \frac{\text{force} \times \text{distance}}{\text{time}}$ = foot-pounds-minutes or seconds. The time element in the formula is expressed in minutes or seconds. A foot-pound-minute, the unit of power, is defined as being the work necessary to raise one pound one foot in one minute, and, the foot-pound-second, the work necessary to raise one pound one foot in one second.

In the example of the man carrying the cement, the work performed was the same in either case irrespective of the time; that is, 1000 lb. was raised 50 ft., or 1000 lb. × 50 ft. = 50,000 foot-pounds of work was performed. When we come to consider the time element, each one will represent a different rate of doing work. For example, if the man did the work in one hour (60 min.), the rate of doing the work, power $= \frac{\text{weight} \times \text{distance}}{\text{time}}$ $= \frac{1000 \times 50}{60} = 833$ foot-pound-minutes. If the time required is two hours (120 min.), then the power developed $= \frac{1000 \times 50}{120} = 417$ foot-pound-minutes. Hence it is seen that if the time element is double for doing a given piece of work, the power developed, the rate of doing work, is only one-half. In other words the individual or device is only working one-half as hard.

We may summarize the definition of the three elements thus: *Energy is the capacity or ability for doing work; work is the expending of energy (this is accomplished when a force overcomes a resistance); and power is the rate of doing work, or the rate at which energy is expended.*

Power-developing devices are usually rated in horsepower. The horsepower was defined by James Watt, as the result of his experiments with strong draft horses, as being the equivalent of the work necessary to raise 33,000 pounds one foot in one minute, or 550 pounds in one second. This may be expressed as the work necessary to raise 330 lb. 100 ft. in one minute. This unit was adopted by Watt in the rating of his steam engines and has been used since then as a unit for rating of power equipment. Since the horsepower = 33,000 foot-pound-minutes, the rate of doing work of any device expressed in horsepower $= \frac{\text{foot-pound-minutes}}{33{,}000}$.

Whenever energy is expended—that is, work done—it manifests itself in the form of heat. The energy expended in overcoming the friction of a bearing manifests itself by heating up the metal, and if the bearing is not properly lubricated to reduce the friction, the expenditure of energy necessary to overcome the friction would be so great as to heat the metal to the melting point and destroy the bearing. If a piece of metal is struck a blow with a hammer, it is heated; here the energy expended in the blow is converted into heat where the blow is struck. These examples are almost unlimited. The one that is most familiar to us all is that when coal is burned in a furnace under a boiler, the energy stored in the coal is liberated in the form of heat and passes into the water, converts the water into steam, which in turn transmits the energy to the cylinder of the engine where it is utilized to drive the engine and its load. From these examples it will be seen that there is a very close connection between work and heat. In fact, work cannot be performed unless a certain amount of heat is produced.

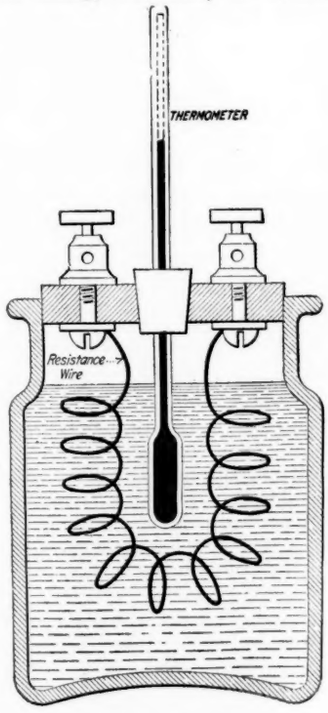


FIG. 3. APPARATUS FOR DETERMINING HEAT OF AN ELECTRIC CURRENT

After James Watt's time there flourished an English physicist, by the name of James Prescott Joule, who

by experiments determined the amount of heat produced in doing a given piece of work or, as it is usually called, the mechanical equivalent of heat. The principle of the apparatus used by Joule in his experiments is illustrated in Fig. 2. The weights W were raised by turning the crank C, and then, by allowing the weights to fall, the paddle wheel P was caused to revolve in the tank T, which was filled with water. The weights W in pounds times the distance in feet through which they fell, minus the friction in the connected mechanism, would give the work done on the paddle wheel P in overcoming the resistance of the water. Then by taking the temperature of

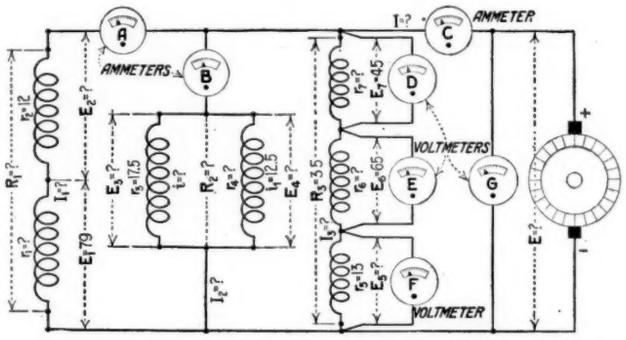


FIG. 4. ELEMENTS GROUPED IN SERIES AND PARALLEL

the water before and after the experiment, the heat equivalent of the work expended on the paddle wheel was determined. From his experiments Joule came to the conclusion that when 772 foot-pounds of work was expended in one pound of water, its temperature would be increased one degree F. Joule's apparatus was crude; consequently, as would be expected, the results were not accurate. Later experiments have shown that the correct value is 778 foot-pounds. The difference between the two values is very small, when consideration is given to the conditions under which Joule had to conduct his experiments.

The work necessary, when performed on one pound of water, to increase its temperature one degree F. (778 foot-pounds), is called a British thermal unit (B.t.u.). Since, when 778 foot-pounds of work is performed in one pound of water, the temperature of the latter is increased one degree F., if one horsepower (33,000 foot-pounds) is done the temperature of one pound will be increased $\frac{33{,}000}{778} = 42.42$ deg. In other words, one horsepower is equivalent to the heat necessary to increase the temperature of one pound of water 42.42 deg.

The rate at which energy is expended in an electric circuit (power) is equal to the current in amperes multiplied by the volts impressed upon the circuit. The product of volts times amperes is called watts, after James Watt, the Scottish inventor, who was responsible for much of the early development of the steam engine. That is, electric power, watts = amperes $\times$ volts. The symbol for watts is W and the formula is written $W = EI$.

Whenever an electric current flows through a circuit, it manifests itself in the form of heat. It was by taking advantage of this fact that a connecting link was established between electrical and mechanical power.

By the use of an apparatus similar to that shown in Fig. 3, which shows a vessel filled with water in which a coil of resistance wire is immersed, the heat equivalent of an electric current was determined. By passing an electric current through the coil it was found that when energy is expended at the rate of 746 watts, for one minute, the temperature of a given volume of the water is increased the same amount as when one mechanical horsepower of work is done upon it (33,000 ft.-lb.-min.); namely, the temperature of one pound of water is increased 42.42 deg. F. Hence we may say that 746 watts of electrical power is the equivalent of one mechanical horsepower and is called an electrical horsepower. Therefore electrical horsepower $= \frac{\text{watts}}{746} = \frac{W}{746}$. Since $W = EI$, we may write electrical horsepower $= \frac{EI}{746}$

In the problem, Fig. 1, $E = 140$ volts and $I = 35$ amperes; then the watts, $W = EI = 140 \times 35 = 4900$ watts. Electrical horsepower $= \frac{W}{746} = \frac{4900}{746} = 6.57$ horsepower.

The study problems are as follows:

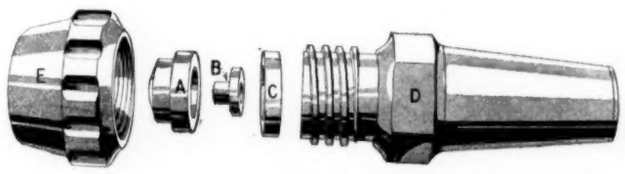
1. In addition to finding the values indicated on Fig. 4, find the total watts and electrical horsepower, also indicate what each instrument will read? Note: The resistance of an ammeter may be considered as being of zero value.

2. An electrical motor, when connected to a 220-volt circuit takes 37.5 amperes from the line. Find the power supply to the motor in watts and electrical horsepower?

3. A 7.5-ohm resistance is connected to a 375-volt circuit. Find the value of the power in watts and electrical horsepower supplied to the resistance?

Monarch Atomizing Nozzles

An atomizing nozzle known as the Monarch is made of stoneware so as to obviate breakage of the spray tips due to sudden change in temperature such as occurs when used in connection with acid chambers. The interior of the nozzle consists of but two parts, A and B, both of which are of stoneware. The inner part B is loose-fitting to allow easy removal for cleaning. It is held in place by a shoulder. Leakage is prevented by a washer C. The nozzle is fitted in the casing body D, which carries a



BODY AND PARTS OF MONARCH SPRAY NOZZLE

cap E. This nozzle is designed for pressures up to 100 lb. and will, with water, give a fine spray with pressures as low as 10 lb. The tips cover any capacity desired from 2.5 to 20 gal. per hour. A multiple-spray nozzle for cooling condensing water, made with three parts, gives a satisfactory spray at 2½ lb., and at 3½ to 5 lb. as fine a spray as is required for cooling purposes. This nozzle gives a double spray. The Monarch nozzles are manufactured by the Monarch Manufacturing Works, Box 2070, Philadelphia, Penn.

Entropy and Some of Its Uses—II

By F. R. Low

SYNOPSIS—Shows how to determine the energy derivable by the expansion of a pound of steam between given limits.

On page 720 of *Power* for May 29 an attempt was made to tell what entropy meant and to explain the construction and meaning of the temperature-entropy diagram. It is now purposed to explain some of the uses to which this knowledge of entropy can be put.

How much energy is derivable from a pound of dry-saturated steam expanding from 150 lb. abs. to the pressure of the atmosphere?

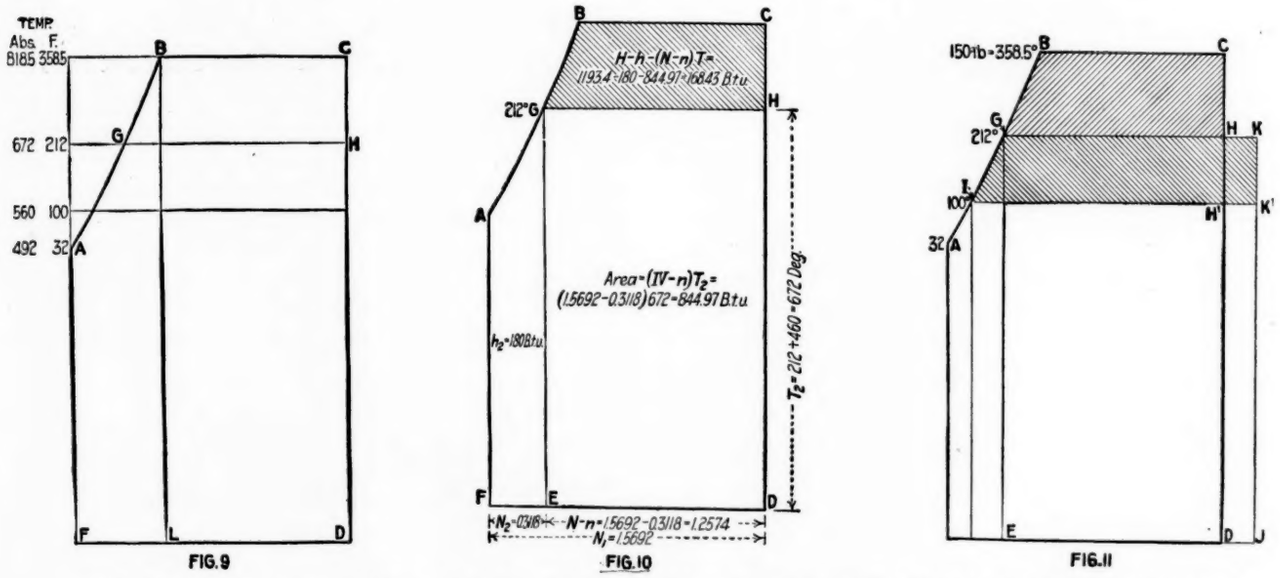
In Fig. 9 we have a diagram the height of which is proportional to the absolute temperature (358.5 + 460 = 818.5 deg.) of steam at 150 lb. abs., and the area of which is proportional to the 1193.4 B.t.u. that it would take to make a pound of dry-saturated steam of that pressure out of a pound of water at 32 degrees.

To represent the addition of heat on such a diagram the point is moved to the right; to represent the loss of heat the point would be moved to the left. To represent the expansion of steam from 150 lb. abs., or 358.5 deg., and the dry-saturated condition—which state would be represented on the diagram by the position of the point *C*—to atmospheric pressure, or 212 deg., without either receiving or giving up heat save as it converted it into work, the point would move down the vertical line *CH* from the 358.5- to the 212-deg. level. This mode of expansion, in which the steam neither receives heat from an outside source nor gives heat out, in which the steam may be conceived to be inclosed in a vessel the walls of which are un-pass-through-able, is called adiabatic, or commonly referred to as isentropic expansion.

"Iso" or "is" is a prefix used to indicate equality; isentropic means having equal or constant entropy, as does the line *CH* along which this change of state is supposed to have occurred.

The pound of stuff with which we are working (some of which will now be water and some steam, for there has been condensation due to the conversion of some of the heat into work) is, after such expansion, all at 212 deg., and the diagram representing the heat remaining in it must be bounded on the top by the 212-deg. line. If the entropy remains the same, the diagram must be bounded on the right by the line *HD*. The heat still in the mixture at 212 deg. is then represented by the unshaded area *AGHDFA* of Fig. 10, and the heat represented by the shaded area *BCHGB* above the 212-deg. level has been converted into work. If we can find how much heat is represented by the unshaded area, we can, by subtracting it from that represented by the whole area *ABCDFA*, determine the amount represented by the shaded portion and convertible into work.

This can be easily done. The area *AGEFA* represents the heat of the liquid *h* at 212 deg., and a glance at the steam table will show this to be 180 B.t.u. The height *DH* of the rectangle which remains is the absolute temperature at 212 deg. F. = 212 + 460 = 672 deg. abs. The total width *FD* of the diagram is proportional to the total entropy *N* of the steam = 1.5692. The width *FE* of the portion representing the heat of the liquid is proportional to the entropy *n* of the liquid at 212 = 0.3118.



FIGS. 9 TO 11. ILLUSTRATING APPLICATION OF TEMPERATURE-ENTROPY DIAGRAM TO THE EXPANSION OF A POUND OF STEAM

a = not, un, as in a-chromatic = uncolored;
dia = through as in dia-meter = through measure;
batos = to pass.

All these values are given in the steam tables. The width *ED* of the rectangle, then, is $N - n = 1.5692 - 0.3118 = 1.2574$; and its area is the product of its width and height $(N_1 - n_2)\ T_2$ or $(1.5692 - 0.3118)\ 672 = 844.97$ B.t.u.

The area of the whole diagram represents the total heat of the pound of dry-saturated steam at 150 lb. abs., which the steam table gives as 1193.4. If from this

we take the 180 B.t.u. represented by the area *AGEFA* and the 844.97 B.t.u. represented by the area *GHDEG*, the remainder will be the amount of heat represented by the area *GBCHG* and which has been converted into work. So we have representing the initial and final states by the subscripts 1 and 2 respectively,

$$U = H_1 - h_2 - (N_1 - n_2)\ T_2$$

where

U = Heat converted into work, B.t.u.;
H = Total heat of saturated steam, B.t.u. per lb.;
h = Heat of the liquid, B.t.u. per lb.;
N = Entropy of the steam;
n = Entropy of the liquid;
T = Absolute temperature.

A convenient form for working this formula is:

$$\begin{aligned} & & 1193.4 &= H_1 \\ N_1 = 1.5692, & t_2, 212 & 180.0 &= h_2 \\ n_2 = 0.3118, & 460 & 1013.4 &= H_1 - h_2 \\ N_1 - n_2 = 1.2574 \times 672 &= 844.97 & (N_1 - n_2) T_2 & \\ U = 168.43 &= H_1 - h_2 - (N_1 - n_2) T_2 & & \end{aligned}$$

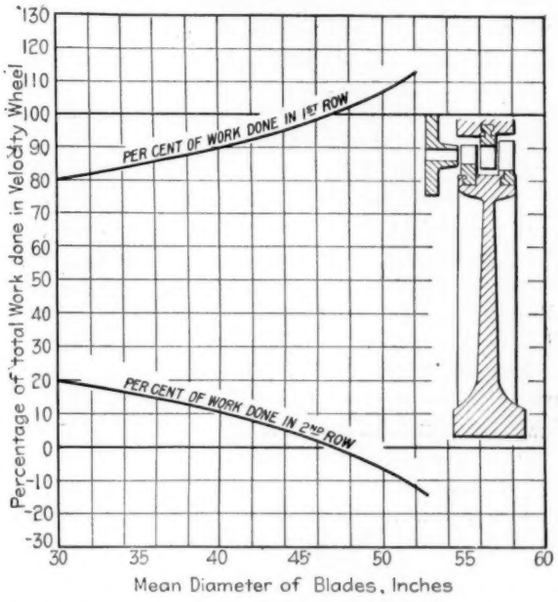
It was a matter of surprise to many engineers that they were able to get about as much energy out of a pound of steam by working it from atmospheric pressure into a condenser with a high vacuum as by working it from 150 lb. to atmospheric pressure. Fig. 11 shows at a glance that the energy derivable from the extra expansion is nearly as much as by expansion to 212. As the steam expands, it condenses on account of the conversion of some of its heat into work, so that when the pressure reaches atmospheric at H we have no longer a pound of dry-saturated steam to work with, but a mixture of steam and water. If the expansion is continued with this mixture as in another stage of a turbine, an amount of work proportional to the area *GHH'IG* would be derivable—if the machine were of 100 per cent. efficiency—but if the steam were dried out or brought back to the dry-saturated state at 212 by adding an amount of heat proportional to the area *HKJDH* or, what amounts to the same thing, if the water were removed as by a separator between an engine and a low-pressure turbine, the expansion of this pound of dry-saturated steam from 212 to 100 deg., or from the pressure of the atmosphere to a vacuum of about 28 in., would generate an amount of work proportional to the area *GKK'IG*, which is actually more than that represented by the area *GBCHG* derived by expanding the pound of dry-saturated steam from 150 lb. to the pressure of the atmosphere.

Failures of Diesel-Engine Crankshafts—The object of a paper read before the Diesel Engine Users' Association by Philip H. Smith was to show that the life of the crankshafts of Diesel engines is mainly dependent on the engineer in charge and may be prolonged indefinitely if certain reasonable and simple precautions are taken. He said that all the failures he had investigated were due to lack of alignment of the main bearings, usually resulting from unequal rates of wear of the several shaft bearings, though attributable in some cases to negligence during erection or, in older engines, to defective foundations. The type of engine least liable to shaft fracture is the three-cylinder and the worst is the four-cylinder, though the two-cylinder runs it very close if fitted with a heavy flywheel. Nearly always the shafts fail through the webs, the crack starting at the center and working outward. In single-cylinder units either web may fail; in two-cylinder engines web 4 fails most frequently (the webs being numbered consecutively from the end farthest from the flywheel); in three-cylinder units the fracture occurs in either web 1 or 6, and in 1 as often as 6; and in four-cylinder engines almost invariably web 4 fractures.—"Electrician," London.

Initial Velocity Stages for Steam Turbines

In a paper on "Steam Turbines for Land Purposes," presented by H. L. Guy to the Manchester Association of Engineers and reported in *Engineering*, the author says:

"The success of impulse turbines has been in a large measure due to the fact that the pressure and temperature inside the turbine casing are kept low by allowing a much larger expansion in the first than in succeeding stages, with the result that the full boiler steam pressure and temperature is confined to the steam chest and nozzle boxes, which are small chambers and can, when necessary, be made of cast steel at a reasonable cost. In turbines whose blades rotate at a slow or moderate peripheral speed, the steam velocity resulting from this large initial expansion can be utilized most efficiently in a velocity wheel having two rows of moving blades, but, with a given expansion, as the peripheral speed of the blade increases, the work done in the second row decreases, whereas the friction and windage losses increase as some power greater than the cube of the speed. It will therefore be readily understood that a point will be reached when the second row of blades does not perform enough work to rotate it at the required speed, the deficit being made up by the first row. This effect is illustrated in the accompanying diagram. It will be seen that with the conditions stated, and with the blades having 30 in. mean diameter, the addition of the second row increases the stage efficiency by 25 per cent.; but that if the mean diameter is 47 in., the second row makes no contribution to the work done in the first stage, so it can be dropped with advantage."



WORK DONE, FIRST AND SECOND ROWS OF VELOCITY STAGE, WHEELS 3000 R.P.M.

Initial conditions: 200 lb. per sq.in. gage; 200 deg. F. superheat; pressure in casing, 34 lb.; temeprature in casing, 410 deg. F.

Electric-Power Service—Where an electric-power company contracts to furnish a motor for use by a consumer of its electricity, the latter is liable for excess current used on account of the motor being out of good condition, if he assumed the obligation of keeping the motor in proper order. (Alabama Supreme Court, Cassels vs. Alabama City, Gadsden & Atalla Railway Co., 73 Southern Reporter, 494).

Regulation of Power Plants Warranted on Ground of Efficiency as Well as Safety*

If an accident is an economic loss, is not sustained waste equally a communal drain against which the public has a right to be protected by legislation?

By Dr. Frederick Remsen Hutton†

The writer had a recent opportunity to claim that an accident in the power house increases the high cost of living. It does this by increasing the cost of production in the individual plant and hence the upward tendency of the market price. It may be also stated that industrial safety and freedom from accident act as a means of lowering the cost of production in any factory or shop, and the introduction of safety devices and safety management may be defended on purely economic grounds.

First, every machine (and a power-house boiler and engine and generator are in this class) should be functioning continuously if possible, to earn the interest on its cost and pay the proper share of overhead charges.

Second, an accident that involves the machine or disables its operator, or both machine and operator, breaks into this continuity of earning and involves losses. These losses fall into several groups: First, the cost of repair; second, the losses of idleness; third, the costs of compensation for bodily injuries, or of insurance against this cost; fourth, the costs in wasted stock and defective work, due to teaching a new operator, also in the slow and inferior production of the worker as yet inexpert; and fifth, the costs of the slackened speed of all workers in the department while the memory of it is fresh in the minds of those who witnessed the accident.

There are furthermore indirect losses from the accident, which reach the community only through the heavy losses borne in the narrow circle affected when its wage earner is disabled. These are the losses in buying capacity when full wages are no longer received; in losses of schooling and in lowered standards of living in such circle of dependents of the victim; and there is finally the more inclusive community loss in the hospital costs.

Cost of Power a Large Factor

It should need little or no argument to convince that the cost of power appears as a factor in the cost of every manufactured article or product, whether the power is generated within the producing plant or is brought into it on a rental or service basis. Almost everything that we use in these days has had power and labor expended on it at every step from the raw-material stage to the final transportation to the consumer's plant or home; hence, increased cost of power and of transportation of fuel and material for manufacturing is a charge paid by every consumer. Every consumer is for this reason interested in preventing accident in the power house, and both legislative and executive branches of a democratic government are justified in taking measures to prevent and minimize such accidents and their economic burden.

Natural instinct and common sense would send experts and commissions to remedy this state of affairs, and such study and remedial action would not be deemed meddlesome nor improper nor an invasion of any personal liberty. In other words, the response and reaction to excessive loss is instinctive and defensible.

Has the way then been cleared for the next step in logic and economic progress? If accidents are a waste to be prevented because of their cost, are other preventable economic wastes a similar community waste, and may the community take steps to protect itself?

An excessive cost of generation of power is of course first borne by the producing plant, but such plant at once faces an alternative. It may keep its prime or factory cost what it has been by reducing some other element, usually the wages of the operators, and thus meet the competition of its rivals; or it may let the prime cost go up and hope to carry the market or selling price up with it, if it can.

Let these two alternatives be studied for a moment. It is to impoverish the community to reduce wages on the one hand, because all tradesmen who sell to the poorer buyers find their market invaded—the latter buy fewer and poorer shoes and clothes, less food and pay less rent. If on the other hand, the market price of the manufacturer can go up without a cut in wages, then it is all the buyers of that product who are impoverished, for they have less to buy other things with or they buy less. If the market price cannot go up by reason of sound competition, then the plant with excessive power cost will soon go out of business, discharging its men, forcing withdrawal of savings of former years and throwing dependent relatives of the idle men on community beneficence. This is an obvious impoverishment.

If on the other hand again, by the help of transportation problems or other forces the higher price can be maintained, then the community calls first on the boycott or other form of closed market, or by the public service commission investigation it seeks to punish the offender and to protect itself.

The writer is an individualist by theory and by preference. Our ancestors won their economic conquests by individual ability and effort. Strong men are developed under this philosophy, and opportunity is always the prize of the individual. But as the community grows in size and its activities in complexity, the need for associated action increases. We have to get our water by a corporate plan and no longer from our private and individual well; we must dispose of our sewage in an organized system and not merely cast it into a hole in the ground. So as we have grown accustomed to the idea of having the community legislate to prevent and minimize accident in the power house and factory, is there any logical pausing stage before the community demands economy and efficiency in the use of increasingly precious and costly fuel in the generation and distribution of power, with a view to lowering the cost to the community of such commodities as call for power in their production?

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*From "American Machinist."

†Past president of the American Society of Mechanical Engineers, professor emeritus of Mechanical Engineering at Columbia University and vice president of the American Museum of Safety.

Editorials

Nationalizing Productive Methods

After one has waded through considerable literature by certain German writers, he concludes that the German idea is neither moral, spiritual nor political, but utilitarian. As has been said by others, the greatest resource of Germany is her people. She has immeasurably enhanced the value of her natural resources by increasing the utilitarian value of her people, by making them acquire an unparalleled efficiency in the development and use of the natural resources.

The German people may be crushed in bitter defeat at arms, they may be starved and made slaves in bondage until an unprecedented indemnity is paid—they may suffer all these things and more—but they will have been victorious in the sense of having forced the world to adopt and apply efficient organization to industry, commerce and politics on a more scientific and on a broader engineering basis, on a more nationalized basis than it dreamed it ever would. The German idea is preëminently an industrial success. It would be a social success if it were not a spiritual failure.

America, Great Britain, France—the world, in fact—knew efficiency, organization and nationalization before July, 1914, but they did not know it as they know it now. In the great emergency every belligerent has turned to the engineer to find a way out. The article by Dr. Frederic R. Hutton, appearing elsewhere in this issue, is, because of the foregoing, exceedingly interesting. Dr. Hutton asserts that it is the public's business how wasteful, whether of life or of resources, an industry may be. We are beginning to be convinced that private waste is public loss.

All belligerent governments have taken steps to minimize such waste in the interests of the governed. Following the lead of Saxony and Bulgaria, Prussia is now taking up the control of the state electricity supply. The British Board of Trade is considering the advisability of state control of the electric generating plants. This does not mean central stations only, but it means all plants that generate electricity for light and power. The British Board of Trade has also interested itself in the fuel situation, and Great Britain, along with other countries, has a fuel controller who looks after the distribution of fuel. There has recently been organized a Fuel Board, whose business it is to look into the waste occurring in the use of fuel. Through this commission the government is telling fuel users that it is its business whether they are using fuel with an efficiency of thirty per cent. or whether they are getting an excusable sixty-five.

In Great Britain the scrap from alloys cannot now be disposed of except by direction of the Minister of Munitions. To conserve materials and efforts, the Northeast Coast Engineers have drawn up specifications to the end that shipbuilding, as well as the equipment for ships, may be standardized. The movement is favorably regarded by most of the societies interested in naval architecture. A good indication of what the new era is to be is evidenced by one of the oldest and most conservative engineering organizations taking up the study of languages and economics in order that its members may more successfully meet the conditions that are to come.

From the foregoing and from what Dr. Hutton has to say, it is evident that the time will soon be here when not only will the government seek to regulate safety measures as applied to power plants, but the state will inquire into the efficiency of operation of such plants. For the operating engineer it means a more thorough knowledge of his art, which can be gained only through deeper and wider study and broader experience.

The Importance of Accurate Electrical Instruments

The accuracy of electrical measuring instruments is one of the most important factors in the operation of a power plant, yet, especially in the smaller plants, this feature is in many cases given only superficial, if any, attention. At the switchboard the voltmeter is of greatest significance, for on it depends the voltage at which energy is supplied, and the importance of correct voltage at the terminals of electrical devices cannot be overestimated. If the voltage is reduced below normal at the terminals of incandescent lamps, the candlepower falls off rapidly and results in reduced efficiency, not only of the lamp, but also of those who have to work under the light. If the power is supplied from a central station, it also results in a reduction of revenue to the utility company, as well as inadequate service to the customer. On the other hand, if the voltage is high it shortens the life of the lamps.

A voltage other than that for which a motor is designed affects the starting torque, speed, temperature, capacity and efficiency of the machine. This in general causes a decrease in efficiency of operation of the machinery it drives. In many cases a decrease in speed affects not only the output of the machine, but also the quality of the product. Yet how is the correct voltage to be known unless the operator has a reliable voltmeter on the switchboard?

In the operation of alternating-current circuits correct frequency is only secondary to correct voltage. The speeds of all alternating-current motors are affected by the frequency; in fact, a variation in frequency will have all the effects upon a motor that a variation in voltage will, only in some instances in the reverse order. Hence, it is very essential that the frequency meter be correctly calibrated.

It is also of no small concern that the ammeters and wattmeters read correctly if the machines to which they are connected are to be operated efficiently and not overloaded. In series-lighting circuits the ammeter must give a correct indication if the lighting service is to be up to the standard.

On many alternating-current systems means are taken to correct the power factor, but these efforts fall short of what they are intended to attain unless the power-factor

instrument is reliable and properly calibrated. Another point too frequently overlooked with alternating-current instruments is the transformers used with them. These should be carefully checked with the instruments they operate.

Central stations in general, in recent years, have been giving special attention to the accuracy of the watt-hour meters on their customers' premises and have found it to be a profitable practice. A slow-running meter represents a direct loss in revenue, and a meter that is running fast, although it gives a greater revenue, frequently results in a diminished profit, since collecting bills and adjusting matters cost more than the increase in revenue, besides invariably resulting in a dissatisfied and suspicious customer. In central-station operation the accuracy of watt-hour meters is one feature that the public-utilities commissions are giving attention to, and where the commissions have supervision, they require that a complete record be kept of customers' complaints, periodic tests of watt-hour meters installed on customers' premises, etc. Furthermore, if a meter is found running over a certain percentage fast, the utility is required to give a rebate to the customer.

In these days electrical measuring instruments that are accurate and reliable can be obtained for reasonable prices; therefore there is no reason for any power plant, whether central-station or isolated, not keeping a check on its instruments. Even though it may not have the facilities for calibrating them, it can have standard instruments that may be used to compare the readings of the switchboard equipment, and when found in error, sent to some testing laboratory for calibration. Such a practice will be found to pay an excellent dividend on the investment. Low-efficiency power-plant equipment in general only increases the amount of coal burned, but inaccurate instruments cause general inefficiency.

Steam-Turbine Rope Drive

It was but a few years ago that engineers gravely discussed the practicability of the steam turbine as compared with the reciprocating engine. Many were prejudiced against the turbine, and its efficiency as a prime mover was seriously doubted. Its development, however, is without precedent. Not only has it permanently invaded the large and small central station field but it has gained a firm foothold in the industrial plants for driving electric generators, rotary blowers or for operating rolling mills. A more recent application is in driving lineshafts by means of belt or rope drive.

An interesting example of this last-mentioned application is described in the leading article of this issue. Here a 1680-horsepower turbine with a speed of 3280 revolutions per minute drives two main lineshafts of a mill by means of rope drives and reduction gear between the turbine and the driving pulleys. This is an innovation that a few years ago would not have received serious consideration at the hands of engineers, but in the instance cited its practicability seems to have worked out with much satisfaction to all concerned. The fact that the unit is operated in conjunction with several waterwheels makes the installation of interest, as under the conditions of fluctuating water supply the turbine transmits only such power as is required to keep the mill shafting up to normal speed.

Doubtless the final decision regarding the type of prime mover to use was governed largely by the first cost. Changing from engine and waterwheels to electric drive would have been expensive; in fact, the change would have cost about ninety per cent. more than the equipment that was installed.

Do Not Call Off the N. A. S. E. Convention

A subordinate association of the National Association of Stationary Engineers, actuated by the most commendable motives, is, we understand, seeking the concurrence of the other associations in the calling off of the national convention at Evansville, in September, and giving the money that would have been spent in this convention to the American Red Cross. We are inclined to believe that sentiment has here usurped the place of better judgment.

If the proposition were concerned only with the diversion to war relief purposes of the funds that would ordinarily be devoted to entertainment and usual convention features, there would be but one answer; but the convention this year affords a splendid opportunity for the operating engineers, collectively, to render a real service to the nation. Elsewhere in this issue there appears an article dealing with the developments during the last three years that are likely to affect the future of the operating engineer. There is no question that when the world is organizing its industries on an unprecedented engineering basis, with the governments and the public taking a keen interest in the efficiency of the industries and the uses of our natural resources, the operating engineer will be called upon to perform his work with much less waste than has heretofore been common.

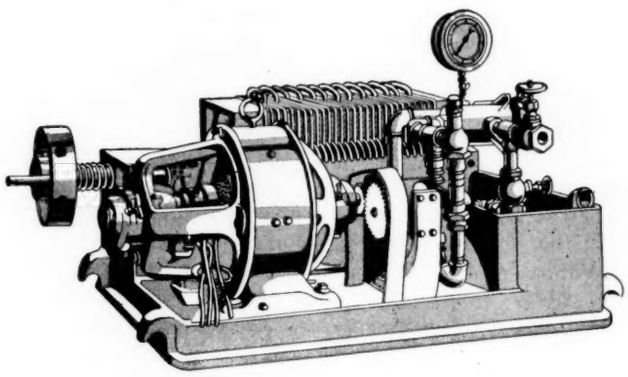
The National Association of Stationary Engineers should not call off the convention at Evansville, but it should meet and insist that the conventions from now on be devoted more vigorously to the engineering art than to the conduct of the organization's routine business. Other great national engineering societies devote but three or four days to their annual meetings, and yet during this short period there are presented usually scores of papers dealing with the progress of the art, all for the purpose of educating their members in the better fulfillment of their work. If the National Association would meet and conclude to conduct its annual meetings as do some of the other engineering organizations, it would find that this would be worth far more to its members, than has its practice heretofore.

A code is a matter of evolution, growth and development. A committee hears representatives of all the interests affected and out of the conflicting tangle frames an instrument which promises to effect more or less perfectly its purpose without being too onerous to anybody. But when the shoe is put on and the wearer commences to work in it, a bind is found here and a slip there, a chance for improvement somewhere else. Things which in the light of their discussion were perfectly clear to the committee turn out to be ambiguous or difficult to understand without that illumination. The maintenance of a permanent committee to interpret the A.S.M.E. Boiler Code and to recommend revisions in it where necessary is a wise measure giving this faculty of evolution full sway and permitting the code to adapt itself by use.

Correspondence

Transformers Failed

Before oil is passed for use in transformers, it is subjected to a high potential test and its quality and dryness must be such that a 0.2-in. thickness of the oil will withstand a test voltage of specified value—usually from 25,000 to 40,000 volts according to the voltage rating of the transformer. Oil as supplied by the manufacturer is of standard quality and dryness; but the history of the oil during the time that elapses between its shipment and its use has much to do with its ultimate effectiveness as an insulator. Although oil and water ordinarily are not supposed to mix very freely, a very small percentage of water will lower the dielectric strength of the oil to a great degree. In the best practice, in order to obviate all uncertainty, it is customary to test the oil just before using it, and if the test indicates the presence of moisture, the oil is dried by passing it through a filter designed especially for the purpose, as shown in the figure. That not



FILTER PRESS FOR OIL DRYING

only the condition of the oil but the oil itself may be overlooked in the haste that often attends hurried installing is indicated by the following instances, in each of which the transformer failure was due to irregularities that had to do with neglect of the oil.

In the first instance the operator complained that a transformer that had been in use for more than a year had broken down on account of defective insulation. Investigation showed that the transformer was of the indoor type and had just been filled with new tested oil, but had been moved out of doors where it was protected by a temporary shelter. The supply from which the transformer had been filled was tested and found to be of high quality. A sample of oil drawn from the bottom of the transformer was then tested and proved to contain water. Inspection disclosed that the roof of the shelter leaked and that the transformer top had been cracked when it was moved. This explained the presence of the water.

In another instance a pole type of transformer was reported to have failed after two days of operation; the transformer was taken down and removed to the shop for inspection. When opened, it was found to be only half-full of oil. A close inspection revealed a sand hole in the bottom of the tank. The leak was stopped by drilling and tapping a hole through the flaw and screwing a plug into the hole.

In the third instance an operator was much alarmed because three transformers that had just been taken from stock had failed very soon after being installed. Inspection disclosed that none of them held any oil, although there was evidence that all had contained oil at some previous time. It developed that the storeroom had received an urgent call for oil, and as there was none on hand, the storekeeper had robbed the new transformers with the intention of refilling them when oil that was on order should arrive. Unfortunately, the transformers were put into service during the storekeeper's absence and no one else knew that they were empty.

Brooklyn, N. Y. E. C. PARHAM.

Some Old Air Compressors

I have just read the letter by H. L. Hicks under the caption, "An 1887 Air Compressor Still in Service," in the issue of Apr. 17, page 536. We have some old compressors in this plant that may be worthy of mention.

While the compressor described has had two years longer life, one of those in my plant, I believe, has had more days of service. It is a Norwalk two-stage water-jacketed, steam cylinder 24-in., air cylinders 26- and 17-in. respectively, with 30-in. stroke, Meyer's riding-cutoff steam valve gear. It was installed in 1889, and excepting an occasional few days' shutdown for repairs, has 28 years of everyday service to its credit, on the hardest kind of usage in coal mines, and it is still in first-rate condition.

In the same plant I have another compressor of the same make and size that was installed in 1890. We also have 3 three-stage compressors used in the gruelling grind of mine-locomotive charging. While these compressors have always been under the care of competent engineers, they have undergone hard service, being somewhat exposed to dust from the tipple and cinders from the smoke-stacks; nevertheless they are good for many more years of active service. C. DICKERSON.

Cambria, Wyo.

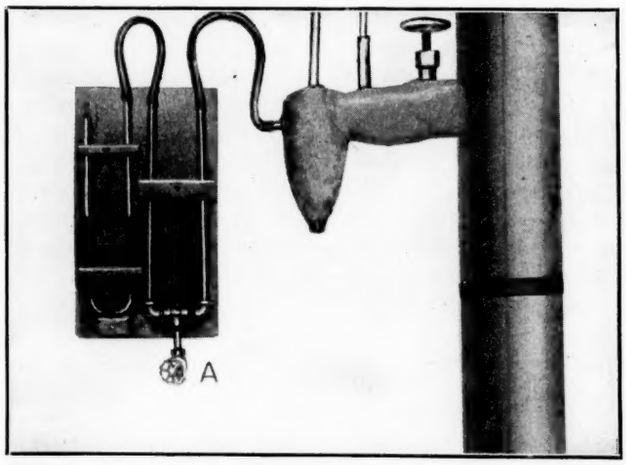
Keeping Exhaust from Freezing

In regard to Mr. Bertrand's trouble with pumps freezing when running on compressed air, as described in the issue of May 1, page 608, I suggest that he adopt the plan which contractors on tunnels and large excavations follow. A small water heater is hooked in on the line, the air passing through the water space on its way to the pump. A slow fire is kept in the heater, sufficient to heat the air enough to prevent the exhaust freezing. It is possible that Mr. Bertrand cannot use a fire in his shaft; if so, perhaps he could use a heater with a steam coil.

South Ozone, L. I. W. H. PYATT.

Manometer Tube Used with Calorimeter

In using a throttling calorimeter in power-plant testing, trouble is often encountered in obtaining an accurate reading of the pressure in the separating chamber, especially when the pressure is such that it is most accurately obtained by means of a manometer tube. One of the chief causes of trouble is that due to steam condensing on top of the mercury column. In order to obtain an accurate reading, it is necessary to disconnect the manometer and remove the water, which is a source of trouble and annoyance and is usually not accomplished without



POSITION OF VALVE BETWEEN MANOMETER TUBE AND CALORIMETER

the loss of some mercury. To avoid this condensed steam on the mercury column, the apparatus shown in the accompanying illustration was tried and found to obviate the trouble. The valve *A* is kept open except when a reading is to be taken. This keeps a jet of steam flowing from the point where water will collect and the steam discharging keeps the pocket clear of water. Care should be taken to have a tight valve at *A* and not to take a reading after the valve is closed until conditions have become constant. This time interval is not off sufficient length to allow water to collect in either the manometer tube or the iron auxiliary tube. J. O. KAMMERMAN.

State College, Penn.

Uniflow Engine Patent Decision

Referring to the statement that appeared in the issue of Apr. 24, page 570, to the effect that Johann Stumpf, of Germany, has been awarded the verdict over the Schreiber Brewing Co. for infringement, consisting of a "Universal Uniflow" engine in the Schreiber company's possession, we wish to state that such information without a statement from this company, which is the builder of the Universal Uniflow engine, would have the effect of creating a false impression.

This decision is not necessarily final, and an appeal will probably be taken in due course of time. The Skinner Engine Co. has not been sued and will protect all present owners and all future purchasers of Universal Uniflow engines in matters of this kind, and will continue to build the Universal Uniflow engine.

This engine is manufactured under a number of patents owned by the Skinner Engine Co., and this company still believes that the final decision will show that its patents do not conflict with the Stumpf patents and in the meantime takes this means of informing present owners of these engines and future purchasers that they will be protected in case of any damage due to any alleged infringement. SKINNER ENGINE COMPANY,

Erie, Penn. A. D. Skinner, Vice President.

Auxiliary Steam-Plant Equipment

I read with considerable interest the editorial in the issue of May 1 in regard to auxiliary steam-plant equipment, in which it is said that many people are still in favor of installing the cheapest possible machinery in stand-by plants, even cutting out the condensers if necessary to reduce the original investment.

One aspect is often lost sight of which, if considered, will frequently result in the discovery that the most efficient plant is also the cheapest to build. Stand-by plants, even if expected to operate for only a very few hours each year, are always built with the idea that they will carry a certain load, and unless sufficient, they will not serve their purpose. If a cheap noncondensing engine or turbine is installed instead of a highly efficient condensing machine, a much larger boiler plant will be necessary to carry the same load, and the cost of the additional boilers, extra piping and larger building, smokestacks, etc., will in most cases be far greater than the difference in cost of the two types of prime movers considered.

For example, a stand-by plant required to carry a load of 15,000 kw. for short periods will, if an efficient condensing turbine is installed, require from 4000 to 5000 rated horsepower of boilers. If the condenser is omitted, the steam consumption will be so much greater that probably twice this boiler capacity will be required, with the result that the cost of the boiler plant would be increased more than is saved by omitting the condenser. It will generally be found that while the less efficient prime mover is itself much cheaper, the cost of the entire plant will be lower for the same capacity if the most efficient prime mover is installed. C. H. DELANEY.

San Francisco, Calif.

Cure for "Rattling" Governors

Among the earlier types of centrifugal flywheel governors there were some of "fearful and wonderful" design—an apparent maximum of links, pins and levers. To keep the "rattle" out of such a governor is the despair of the engineer, but most of it can be avoided, no matter how badly the pins or eyes are worn, by the simple expedient of unbalancing the tension on the two springs or making one weight considerably heavier than the other. The action then is, that the heavier weight or the one having the lesser spring tension will exert a greater force outward, taking up all the slack, while the one with the greater proportionate spring tension will lag as the engine speeds up. As the engine slows, the stronger spring tension will pull its weight inward first and thereby still keep the tension on the pins in the same direction, preventing the rattling sound produced when both weights and both springs are nearly equal.

This, of course, is contrary to the positive instructions that the springs must be adjusted to "exactly equal tension," but no difficulty has ever been experienced with

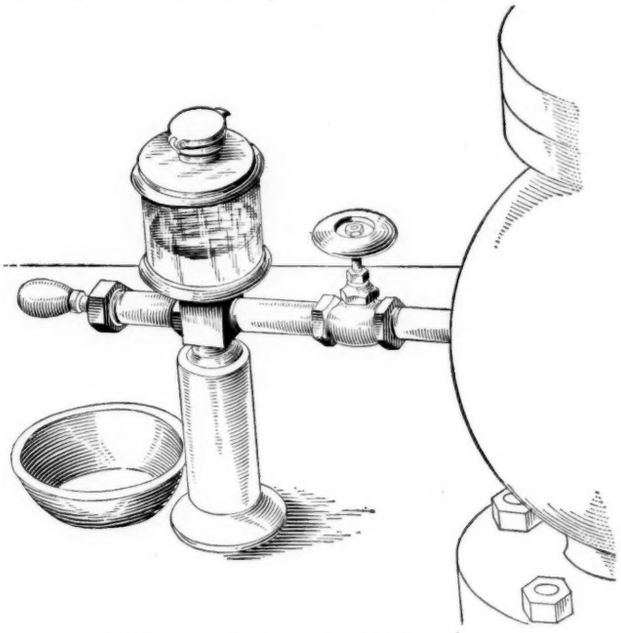
the foregoing adjustment and a number of noisy governors have thus been made to run quietly notwithstanding the pins did not fit the eyes much better than the proverbial "rat's tail in a well."

J. Lewis.

New York City.

Oil-Pump Sometimes Fails

The illustration shows a hand-operated cylinder-oil pump connected to the throttle valve and supported on a pedestal on the engine. The ¼-in. valve between the throttle valve and pump leaks slightly, and steam occasionally backs up into the cup and condenses, and the oil in the cup overflows, making quite a waste and mess. Opening the valve and operating the pump handle sometimes fails to deliver any oil or even water into the engine for some reason. When this happens we close the valve as tight as possible, place a receptacle of some sort under the pump and unscrew the nut next to the oil cup, pull out the handle and plunger, apply a little graphite and replace plunger, and give the handle a few quick strokes. The plunger then "grips" the liquid and forces it into the engine.



HAND-OPERATED CYLINDER-OIL PUMP

Thomas M. Gray.

Middletown, N. Y.

River Shipyards Available

Referring to a short editorial on the building of a large number of wooden ships of about 2000 tons capacity, in the issue of *Power,* Mar. 27, page 428, and also an editorial in the issue of Apr. 24, page 269, all the statements I have seen are to the effect that the lake and ocean shipyards are all working to the limit of their capacity and booked for a long time in the future.

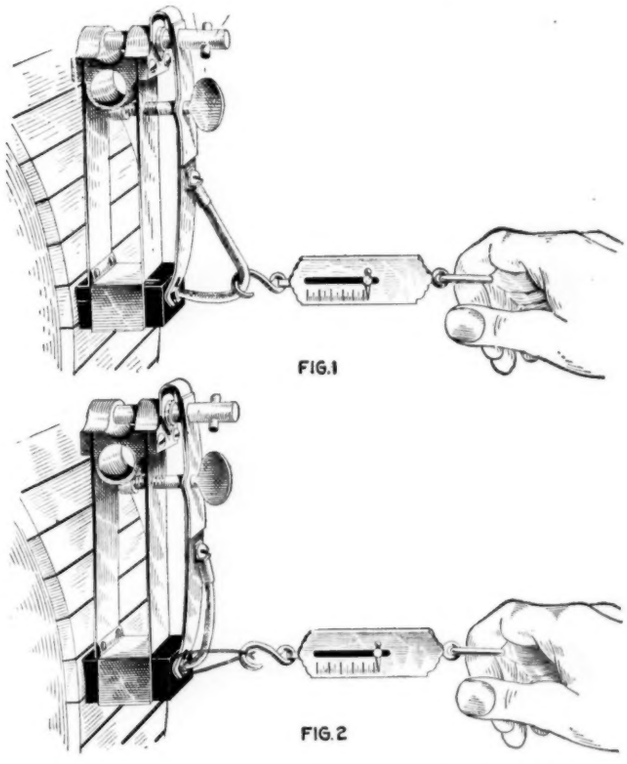
At many points on the Ohio and Mississippi River there are boatyards more or less moribund that might give a very good account of themselves if properly encouraged to go into this business. These river yards could do practically all the work necessary and after the first few months could do it very quickly. Such top hamper as the boats might need could be erected after they passed under the bridge at Memphis and this would be, comparatively speaking, a small job.

It is probable that these ships could not be got to deep water during the low-water season in the fall, but there would be no difficulty in getting them out during eight months of the year. I saw in one of the papers recently that some of these yards had been bought by a firm of Eastern capitalists, and it may be—in fact, is quite likely —that something of this kind is already under way; if not, there is lying fallow in a district well furnished with workmen and materials, facilities for building a considerable tonnage that should be utilized.

Nashville, Tenn. C. H. Crawford.

Testing Brush Tension

After reading an article on commutators and brushes in the Apr. 3 issue of *Power,* I desire to call attention to Fig. 4 on page 449; the illustration is likely to lead to erroneous result. First, this method of measuring brush tension, as shown herewith in Fig. 1, will not give the true brush pressure, because it is applying the force measured at two points: First, where the pigtail attaches to the brush, and second, at a point located where the pigtail is anchored to the brushholder. This method not only does not give the correct brush tension, but very likely will not even give relative values that would be comparative. I believe this is a point that it might be well to correct, as it may lead some fellow into error. The scales should be attached to the brush spring at one point only, that point being at the place where the spring bears up on the brush, as in Fig. 2. Care should also be taken to lift in the line of brush travel in the holder and not at an angle.



FIGS. 1 AND 2. TESTING BRUSH-SPRING TENSION
Fig. 1—Wrong way. Fig. 2—Correct way

Fort Wayne, Ind. L. D. Nordstrum.

Oil or Compound Feeder

With regard to the criticism of Mr. James on page 535 in the issue of Apr. 17, of an oil or compound feeder described by me on p. 161, Jan. 30, I consider that this criticism is not well taken, as further study of the principle involved will show. There is a marked difference in the method of applying the expelling force, which does vary as the velocity of flow in the steam line varies, thereby varying the quantity of oil fed. A study of the principle of the venturi meter will help illustrate this.

In the illustration Fig. 1 on p. 161 the oil level should have been shown to extend to the top of the oil compartment. It is also to be taken that the upper coil of the heater does not communicate with the interior of the oil compartment.

In my opinion an oil pump is an unnecessary and wasteful fitting to install where conditions permit of the installation of a lubricator, as its use departs from the accepted method of continuous feed, the exception being in cases where it is desirable to introduce a quantity of oil prior to starting the unit. THOMAS R. TARN.

Pittsburgh, Penn.

Cleaning Condenser Tubes

We noticed in your issue of Mar. 20 that you raised the question of cleaning condenser tubes. We have a Wheeler condenser with §-in. tubes for the cleaning of which we have tried all kinds of hand methods without success. About three years ago we purchased a steam-driven condenser cleaner, and this is a most satisfactory tool, for it cuts right down to the surface of the tubes and does not injure them at all and the condenser is just the same as when new.

We clean once in two weeks, and in this length of time a hard scale approximately a thirty-second of an inch thick has formed. It takes about a minute per tube, or two hours for the condenser. We figure that the cost, everything considered, does not exceed $2. If we allow the scale to accumulate to more than a thirty-second of an inch, the vacuum goes down to 20 inches and full load cannot be carried, but when the tubes are cleaned the vacuum is 27 inches. H. GLEASON.

Hico, Tex.

Trouble from Hard Water in Boilers

I was interested in reading E. H. Reiter's comments in the issue of Mar. 27, page 429, on my letter of Feb. 13, page 229, regarding "Trouble from Hard Water in Boilers."

Of course we all know that the best way to prevent scale is to remove the scale-forming elements before they get into the boiler or as sludge before scale is formed. I would like a brief explanation of the lime soda pretreatment so that I can tell without a complicated analysis when I have used enough and not too much chemical. Then, having precipitated a lot of sludge, I would like to learn a simpler way of removing it from the treated water before it goes into the boiler. Having done this how can I prevent priming?

Will Mr. Reiter explain his method more fully, so that an ordinary mechanic can understand it?

New York City. GEORGE SMITH.

Operating vs. Rated Efficiency

In calculating the losses in various types of apparatus used in generating plants or substations, full account should be taken of the service conditions to arrive at a fair determination and manufacturers' guarantees do not tell the whole story. For example, the efficiency of a 100-light 6.6-amp. arc generator driven by a synchronous motor may be 75 per cent. for the combination at full load, as recently stated in the Boston Edison street-lighting case. The generator efficiency at full load is 80.7 per cent. and that of the motor 93 per cent., but at half-load the generator efficiency drops to 69.7 per cent. and that of the motor to 89 per cent., making the half-load efficiency of the set 62 per cent. Even this difference does not cover the entire situation as an operating matter, when considered as the year-round losses associated with the service of a particular unit.

At Boston the street-lighting units, excluding rectifier sets installed since the motor-generators were put in, consist of two machines mounted on a common bedplate. Excitation for each synchronous motor requires the expenditure of 1.7 per cent. of the power demand of the pair of generators, and at half-load this excitation represents 3.4 per cent. of the power demand of the pair, since the motor excitation does not change with the change in load.

It is brought out in this case that it would be unfair to figure full-load losses the year through at these units, because as a practical matter it is impossible to operate such sets at their normal rating, despite the fact that the street-lighting circuits utilize a constant current with a fixed number of lamps per circuit, because the series-lighting system presents in its very makeup a serious obstacle to flexible service. The actual number of lamps in use on a circuit in one case differs widely from the number in use on another and does not permit of combinations for loading the machines to full capacity. One hundred magnetite lamps of the 6.6-amp. size represent 8000 volts per circuit; but in actual practice some of the circuits may run below 5000 and other circuits about 6000 volts.

The result is a loading of 63.7 per cent. rating at the L Street generating station, and in order to start the lights, whether from machines or rectifiers, a certain amount of idle running is required. It takes about 20 minutes to get the motor-generator sets running, and it is necessary to run the rectifiers on short-circuits without loads for about 15 minutes. There is an additional idle running loss of about 15 minutes per day on the machines which cannot be avoided, and on dark days the company is subject to call from the city for a half-hour earlier starting time and this must be anticipated. All these losses are registered on the station meters and tend to pull down the theoretical efficiency given by the manufacturer.

These illustrations show the importance of taking operating conditions into full account in estimating the annual losses and the great value of complete information as to the hours of service and local handling of units. The basic guarantees of manufacturers at normal loading have been proved correct, but to evaluate the annual cost of a given power-plant service it is important to take some account of the sag in the efficiency curve to be classified under the term load factor.

Cambridge, Mass. H. S. KNOWLTON.

Nation's Leaders Address Editors

A conference of the editors of business papers with Cabinet officers and other leading Government officials was held at Washington, D. C., in the New Willard Hotel all day Friday, May 25. The avowed purpose of the conference was "to promote the more effective use of the business energies of the country by a closer coöperation of the business press with the Government." The program and all other arrangements were made by two members of the New York Business Publishers' Association.

The following list of speakers, arranged by members of the Publishers' Association, was probably never excelled in prominence and importance: George Creel, chairman Committee on Public Information; Francis S. Peabody, chairman Fuel Board, Council of National Defense; David F. Houston, Secretary of Agriculture; Franklin K. Lane, Secretary of Interior; Newton D. Baker, Secretary of War; Josephus Daniels, Secretary of Navy; William C. Redfield, Secretary of Commerce; Frank A. Vanderlip, president National City Bank, New York City; William B. Wilson, Secretary of Labor; Van H. Manning, Director of United States Bureau of Mines; Herbert C. Hoover, Food Administrator; Walter Gifford, Director Council of National Defense; Frank Scott, chairman Munitions Board, Council of National Defense; Doctor Martin, in charge of Red Cross Work, Council of National Defense; Fairfax Harrison (or a member of his committee), chairman Railroad Executive Committee, Council of National Defense; George Otis Smith, Director United States Geological Survey; R. W. Woolley, Director of Publicity, Liberty Loan of 1917. Several minor changes, as noted later, had to be made on account of unforeseen contingencies. Each speaker gave about a thirty-minute talk on his particular line of work and interest.

The first speaker was Francis S. Peabody, chairman of the Fuel Board, Council of National Defense. His subject naturally dealt with the subject of fuel and the difficulty in procuring sufficient for the needs of the Navy, munition work, steel works and at the same time keeping the public supplied in a satisfactory manner.

GREAT SURPLUS OF FOOD BEFORE WAR

The second speaker, Dr. Pearson, took the place of the Secretary of Agriculture Houston, who was unable to be present. His message was one of optimism. At the beginning of the world war we had an unusual stock of food (a surplus of 100 million bushels of wheat) and shipped 300 million the first year, 240 million the second and this year 175 million, and are not by any means on the verge of starvation. That the price of foodstuff has doubled does not prove that there is a shortage. The crop soon to be harvested will augment our supply wonderfully, and the substitutions possible will mean even more. The reduction of food waste, however, is the prime essential.

Secretary of Commerce William C. Redfield, the next speaker, referred to the great food value of the fish "to be had for the taking." The Bureau of Fisheries of his Department has during the last few years introduced valuable food fish into our waters and markets, two of which are the tile fish, one million pounds per month of which it is estimated was used for food last year, and the grayfish, of which fully two million pounds per month is being used. The Bureau of Standards has been instrumental in discovering and developing glass suitable for optical instruments since the war began, when our previous source of supply was shut off. It is not likely that we will ever import glass from Germany again to any extent for this purpose, as the domestic product equals in every way that previously imported. Chemical porcelain is also being supplied at home instead of being imported. We have also cut the cost of sending the skins of seals across the ocean to be tanned and dressed or even sending to Turkey for oak galls with which to tan the skins, for it has been found that we have an abundance of oak galls equally good in our Western forests. Kelp for fertilizer affords another instance of the rapidity with which we are becoming self-contained. "We are forcing back the darkness and picking out of it the things of value for humanity." It was obvious, he said, that all of the work of his or any of the other departments could not at once be made public, but "in times like this silence is usually a sign of action."

A startling discovery has recently been made that in the English colonies, particularly in Australia and New Zealand, a well-organized propaganda has been carried on for years by German agents to make prominent any editorial or other writing that could be made to prove that there existed a spirit, in the United States, hostile toward England, for the purpose of discouraging importations from the United States and to the benefit of the German trade as a result. The speaker urged that the legislation now pending ("limiting exports" and "trading with the enemy" acts) be not referred to as "embargo acts," for they were not intended as an embargo, but simply that the shipment must be kept track of and not allowed to fall into the hands of the enemy. An example was cited wherein coal was purchased here, shipped to "somewhere in South America" and eventually supplied to "commerce raiders." It was to stop such abuses that the bills were framed. Another case was that of a good American citizen who was about to ship a cargo of ferromanganese to Norway at the greatly advanced price of $400 per ton (on account of its present scarcity). When informed of this country's need of it and the probability of its eventually reaching Germany, he canceled the shipment and turned the consignment over to the Government at a greatly reduced price.

VANDERLIP ON FINANCING THE WAR

Frank A. Vanderlip, president of the National City Bank, New York City, delivered an urgent message to the editors and through them to the American people on the necessity of "organizing for the business of war," such organization to include systematic saving on the part of all, the current savings to be invested in "Liberty bonds." He pointed out that it would not be desirable (if it were possible) to finance the war from the banks or by withdrawing funds from regular business channels, for all capital so withdrawn meant curtailment of business and enterprise, while all bonds purchased from the savings of those earning from $10 per week up meant an ultimate enrichment of the nation. "The cost of this war must come from the savings of the future and not the accumulation of the past." If this plan is judiciously carried out, the annual savings will equal the cost of the war. "The byproduct of the war will be the habit of economy, leading to entries on the right side of the ledger. 'Liberty bonds' are the best of all high-grade investments and are sure to sell at a premium later. Business is going to be better than ever. Business must be made or allowed to be profitable It is not wise to lay on a discouraging tax and throttle business. This is not a paper war; although 3000 miles away, it is real to us. Some are inclined to take a comfortable view of it, that it will probably be over anyway before we get any soldiers over there. This is a big war and calls for a big loan.

PRODUCE MORE, SAYS WILSON

Secretary of Labor Wilson told of what his department was doing to speed up production in all the lines of industry coming under its influence. Several serious-looking labor situations in the coal fields had been cleared up by an appeal to the spirit of patriotism and fair play to the men on both sides of the controversy. The great outstanding feature of the present attitude of all is the desire to coöperate and carry on the work of the Nation. The outlook from his point of view is encouraging. In effect his message was, "Tell your readers to produce more and yet more." There is a general movement toward the transfer of labor from one industry to another during periods of comparative ease in the one while there is a rush in another, notably to the harvest fields where help is always short. Trade and business papers can be of great help in bringing this about. He suggested that advance notice be given of a contemplated shutdown for repairs, etc., so that hands may be arranged with for harvest work. "Carry to your readers the message that there is no hindering 'red tape' in the present conduct of the great work of the Government; tell them that efficiency does exist, and to the manufacturers that there is no coal shortage. More coal is being produced than ever before, and by the new shipping arrangements it will continue to be moved more and more rapidly. Give the President's message all possible publicity."

Josephus Daniels of the Navy told of the needs of the Navy—men, money and ships. While for obvious reasons it was not possible to take the papers and their readers into the confidence of the department as to its activities and preparations, he bespoke the confidence of the people that all skill and speed is being exerted to bring the Navy up to full strength and effectiveness.

The Secretary of the Interior, Franklin K. Lane, referred to his department as the one dealing with the sources of supplies with which to carry on war as well as peaceful pursuits, and since others who were specialists from some of his bureaus were to speak, he confined himself to a general view of the situation. One of his terse epigrams was "Germany today represents feudalism plus science." "Put into your editorials forcibly and frequently that America is not only

fighting for an ideal, but an issue vital to ourselves—to perpetuate a government by consent of the governed as against one dominated by the will of another. Appeal to the patriotism of our people in all activities and enterprises."

Secretary of War Newton D. Baker gave a talk straight from the shoulder along the lines that our enemy is a nation at the head of which are those who, obsessed with a desire for commercial supremacy, have entirely lost their moral balance. The present war is a thing of business and commerce, a conflict "of smokestacks and flywheels," costing sixty to one hundred million dollars and probably ten thousand lives per day. He suggested that, in view of the fact that there must be more or less confusion and the upsetting and jarring of routine habits of living, the press can help by counseling patience and the willing sacrifice of luxuries and ordinary habits, calm apprehension, encourage patriotism and make all criticism constructive.

The first speaker after luncheon was Van H. Manning, Director of the Bureau of Mines, who confined his talk almost entirely to the production and use of oils in the United States. The significant part to the power producer was a suggestion that possibly legislation would become necessary prohibiting the use of crude oil as fuel for making steam, for no matter how costly coal became it should be used to conserve the valuable oils for internal-combustion engines, etc. Conservation is not hoarding but wise use. Increased production of oils is not keeping pace with increased demand, but some promising fields are being tested and oil from shale is commercially possible.

A LONG WAR, SAYS HOOVER

Speaking from his unusual opportunity for observation, Herbert C. Hoover, Food Administrator, declared that in his opinion those who expected to see the war ended in short order were mistaken. "A war of attrition is always a long war, and such tactics are the only ones possible in this struggle." He therefore believed we should provision for a period of three to five years. Stability of prices is essential, but several experiments in England had been failures notwithstanding their avowed soundness in theory. One notable example was the "maximum price" regulation tried and found wanting. Eliminating waste is the most promising outlook to his mind. "Of the total food supply in this country fully 60 per cent. is absolutely wasted. Eat plenty but wisely and without waste." His estimate of the number of men, or workers at least, all along the line necessary to support one man in the trenches was from 12 to 14, showing the necessity of civilian help. He made a strong personal appeal to all editors in referring to the Food Administration Board to "leave Hoover's name out." Criticize the board as such whenever criticism is constructive, but none of its members by name.

Walter Gifford, Director of the Council of National Defense, bespoke the continuance of the support of specially trained men. While nominally the Government departments must carry on the war, they must have the best talent in the country to do so. It should be said that many or perhaps all of the speakers more or less directly referred to the wonderful way in which big men were responding to the call to the country's service, many serving without compensation and nearly all at merely nominal salaries.

Frank Scott, chairman of the Munitions Board, Council of National Defense, made a forcible plea for emphasis of the fact that "we are at war," since so few seem to realize that fact. The needs of the war can be summed up in four m's—men, material, machinery and money. Several examples of the magnitude of the present war as compared with previous ones were given. As many cannon projectiles as were fired by the Federal gunners at Gettysburg in that three days' fight, the greatest action of our Civil War, are now being fired in seven minutes on the western front by either the French or English artilleries, and all the cannon munition (several months' supply) carried by Sherman on his famous march to the sea would last about fifteen minutes. This illustrates by contrast the magnitude of the task of supplying our needs in this one particular alone.

Franklin H. Martin, in charge of Red Cross and other medical and surgical work, told of the magnitude of that branch of work. He said that fully 20,000 doctors will be needed, and while some of the less arduous duties can be performed by the older practitioners, the active field work is scarcely less difficult than that of the men in the trenches. Up to the time of the Russo-Japanese war more men died from what we now consider preventable diseases than fell in combat; so well is the work of the medical staff of an army now done, that the conditions have been reversed.

Howard Elliott (recently resigned president of the New York, New Haven & Hartford R.R.) spoke instead of Fairfax Harrison, chairman of the Railroad Executive Committee. The "platform," or agreement, signed by all of the leading steam roads of the United States was read to show how thoroughly and patriotically the roads had "come to the front" and transferred their entire lines, equipment and operators from president to trackwalker over to the Government use. By this pooling arrangement all the roads are under the operating charge of five big men, and one of the benefits of this arrangement is that all locomotives as well as rolling stock may be diverted to points where most needed. Heavy locomotives may be found on comparatively small roads during rush periods. He pointed out the great advantage of the Railroad Executive Committee over out-and-out Government control and operation.

George Otis Smith, Director of the Geological Survey, told of the mineral resources of the country and assured the editors that no serious shortage existed of the necessary metals for conducting a successful war. It is only a question of manpower to put the metals through the necessary processes to make them available. So far as his branch of the great work is concerned he could afford to feel optimistic.

GEORGE CREEL ON PUBLICITY

Chairman George Creel of the Committee on Public Information, referring to his willingness to accept the work intrusted to him by the President, said: "I took the job because I believe in the press and the freedom of the press and wanted to be where I could help it and grant it all of the freedom possible consistent with the good of the Government and people." The only news we wish to keep from the authorities at Berlin is the kind which would be of tangible help to them in their military operations. His entire plea was along this patriotic line, for surely no one loyal to the allied cause would willingly give aid and comfort to the enemy.

The last speaker of the busy day was Lewis B. Franklin, who substituted for R. W. Woolley, Director of Publicity, Liberty Loan. His message to the business press was based on the fact that their readers were more profoundly influenced by their editorial statements than are the readers of the daily press. "Bring home the necessity of financial support, the desirability of Liberty bonds as a savings fund or permanent investment. Every wage earner from $10 per week upward should own a Liberty bond. Banks all over the country are making arrangements to accept as low as $1 per week as payment for such bonds. Speed up the campaign in your papers." Circulars were available at the rear of the room or at any bank, giving full instructions as to procedure in buying bonds. "Come across with your weekly or monthly savings for the Liberty Loan."

Adjournment was taken at 5 o'clock, after a strenuous day and a highly successful meeting, and it is believed that much good will accrue from it. Credit is due the Committee of Arrangement of the New York Business Publishers' Association, of which David Beecroft, 239 West 39th St., is chairman.

Throttle Valve Burst by Water Hammer

The throttle valve of the main engine in the plant of the National Veneer Package Co., St. Louis, Mo., burst, presumably by water-hammer, at about 4 o'clock on the morning of May 20. The engine develops about 175 hp. at 200 r.p.m. and occupies a room having a floor space of about 8 x 12 ft. The steam pipe, of 4-in. size, passes overhead from the boilers in an adjoining room and drops about ten feet to the throttle valve, which is of angle pattern with a ½-in. drain pipe tapped into the body of it on the under side. This engine stands idle during the night, but steam is kept up to the working pressure of 115 lb. to supply a smaller auxiliary engine, located in another part of the mill, that is run at intervals.

It is presumed that the ½-in. globe valve in the drain from the 4-in. throttle was left tightly closed when the engine was shut down on the previous evening, thus allowing the water of the condensation to gather in the vertical section of the steam pipe. When this pipe became filled to the height of the horizontal section running from the boilers, it is probable that the slight commotion resulting from the movement of further increments of condensation attracted the engineer's attention.

It is not known exactly how the rupture occurred, but it is surmised that the engineer either opened the throttle valve a half-turn or so to let the water pass through the steam chest and cylinder or opened the drain valve, in either case closing the valve before all the water had run out. The shock caused by suddenly arresting the column of water with the 115-lb. steam pressure above it was more than the comparatively light structure of the valve could stand—it being a standard 100-lb. valve—and it cracked diagonally through the body.

The engineer was found by the night watchman lying on the floor beneath the head end of the engine. He had evi-

dently lost his bearings in the cloud of vapor that resulted from the explosion, and was overcome before he could reach an exit. He died later, at the City Hospital.

Exploding Turbo-Generator Kills Four

As a result of the disruption of a 2500-kw. turbo-generator at the Hazelton, Ohio, plant of the Republic Iron and Steel Co., four men were killed, one fatally injured and seven others were more or less seriously injured, shortly after noon on Sunday, May 20.

There were two four-stage turbo-generators of the size of the one that exploded, and both had been in operation about three months. Steam at 140 lb. pressure was used and the normal speed of the units was 1500 r.p.m. Besides these two machines there was a small one and in parallel with them were four 1000-kw. units, one of which was somewhat damaged.

The cause of the accident has not been determined definitely at this writing but it has been attributed to either a mechanical defect or to the governor failing to work, thus allowing the machine to run away. There was but little left of the turbine and the 9-in. shaft was broken at the coupling between the rotor and the generator, the latter remaining on its foundation.

The two new units were placed at a level above the flood stage of the river and the other machines were being raised to the same level, which probably accounts for the large number of men in the turbine room at the time of the accident and which also accounts for the presence of Louis Brostion, an erecting engineer for the General Electric Co., who had been assisting in the work for some time. He was working on one of the new turbines and was considerably battered up from flying fragments.

Those killed were Charles Schuster, chief electrician; Thomas Hennessy, switchboard operator; John McCabe, operating engineer; David Fuchs, pipe fitter foreman. Patrolman David Davis was fatally injured.

Chief Engineer W. R. Bartram, who saw that there was something wrong with the turbine, tried to reach it. Before he could get to the throttle valve an oil receiving box holding about 60 gal. of oil burst and a piece of it hit him on the knee, knocking him down in line with the steam pipe feeding the turbine. This pipe either burst or was wrenched from the turbine, and the force of the steam blew Bartram through a window onto a railroad siding. An erecting engineer, D. B. D'Armin, was standing with his hand on the machine, but escaped with a slight bump on his head.

The accident temporarily crippled the plant insofar as the openhearth, tube mills and the plate and bar mills were concerned. These employ about 2000 men. The property loss was about $75,000. Comparatively little damage was done to the power plant proper, the switchboard suffering the most.

Spring Meeting of the A.S.M.E.

The meeting held by the American Society of Mechanical Engineers at Cincinnati, May 21 to 24, was by far the largest spring meeting ever held by the society, the registration of members alone reaching over 400 against a previous maximum of 223 at Buffalo in 1915. The National Machine Tool Builders' Association held a meeting at the same time and place and had several joint sessions with the Mechanical Engineers. The same entertainment program was participated in by the members of both societies.

Monday was devoted to registration and organization, council and committee meetings, with an informal reception in the evening, at which an address of welcome by Mayor Puchta was responded to by Presidents Ira N. Hollis of the Mechanical Engineers and J. B. Doan of the Machine Tool Builders. Stereopticon views of Cincinnati and surroundings were thrown on the screen, and an opportunity was afforded for dancing.

On Tuesday morning, after a brief business meeting in the course of which President Hollis announced that the council had voted to subscribe to $10,000 of the Liberty Loan, an amendment to the constitution was proposed compelling junior members to advance or withdraw at 30 years of age. The council also approved plans for a classification of the entire membership of the society with a view to assisting the Government in securing the services of specialists in various industrial lines.

The following papers were presented and discussed: "Tests of Uniflow Steam Traction Engines," by F. W. Marquis; "Relation of Efficiency to Capacity in the Boiler Room," by Victor B. Phillips; "Radiation Error in Measuring Temperature of Gases," by Henry Kreisinger and J. F. Barkley; "Development of Scientific Methods of Management in a Manufacturing Plant," by Messrs. Thompson, Lichtner, Hall and Guild; "Disk-Wheel Stress Determination," by S. H. Weaver. A simultaneous session dealt with machine-shop and foundry practice. In the meantime the ladies visited the Rockwood Pottery and the Art Museum.

On Tuesday afternoon the representatives of the local sections held a luncheon at which fifteen of the twenty-two sections were represented. A section has been organized at Toronto, the first outside of the United States. A movement is under way for the organization of a section at Honolulu. A joint session of the society was held with the Machine Tool Builders, and the ladies were taken in automobiles to Fort Thomas, Ky., and tea at the Hotel Altamont. In the evening the men of both societies were entertained at a smoker at the Business Men's Club and amusement was provided for the ladies at the headquarters hotel.

Wednesday forenoon was devoted to a munitions session in which the members of the Machine Tool Builders participated. The ladies played golf or visited the stores and the Union Central Life Tower. In the afternoon there was a boat ride to Fernbank Dam on the Ohio River. In the evening an entertainment was followed by dancing in the ballroom of the Hotel Sinton.

On Thursday forenoon a second munitions session was held, with simultaneous sessions upon the Industrial Safety and Gas Power. The paper upon "The Relation of Port Area to the Power of Gas Engines and Its Influences Upon Regulation" was the only one dealing with industrial power. (This was abstracted in "Power" of May 29.) The usual votes of appreciation of the hospitalities enjoyed were passed, and all agreed that in addition to being the largest, this was one of the most enjoyable and successful spring meetings that the society has held.

ENGINEERING AFFAIRS

The National Association of Master Steam and Hot Water Fitters has temporarily postponed its convention, which was to have been held in Chicago, June 11-14.

The Electric Power Club will hold its annual meeting at the New Willard Hotel, Washington, D. C., June 11-12. The program will be short and snappy, and many well-known speakers are expected to make addresses on general topics of special present-day interest.

The Society of Automotive Engineers will hold its summer meeting at the Bureau of Standards, Washington, D. C., June 25-26. On Tuesday evening, June 26, an informal dinner will be held in the banquet hall of the New Willard Hotel, at which Secretary of War Newton Baker will make an address. It is expected that thirty guests representing the Army and Navy at Washington will be present, in addition to members of the Council of National Defense and other present-day coöperative Government organizations. Members of the British Commission will address the professional session on Tuesday upon general airplane matters. The society's headquarters will be at the New Willard Hotel.

Committee To Survey California Oil Resources—The extent to which fuel oil has replaced coal on the Pacific Coast makes the condition of the sources of oil supply a matter of great importance in war times. Governor William D. Stephens of California has selected two members of a committee of three to obtain facts relating to the production, distribution and utilization of petroleum and to make recommendations on these subjects. The two men named are Max Thelen, president of the State Railroad Commission, who will be chairman of the committee, and Prof. David M. Folsom, of Stanford University. Experts of both the Railroad Commission and of the State Mining Bureau are to assist the committee, which is to hold conferences in San Francisco and Los Angeles with oil-company officials, representatives of the Federal Government and the United States Bureau of Mines. Attention has been drawn to the oil situation recently by the statement from the oil companies that the supply of oil held in storage has been rapidly decreasing. There was a daily decrease in the storage during 1916 of 35,800 bbl., and in the first three months of this year the rate of decrease has been considerably greater. The Southern Pacific, which controls large oil fields, has stated that at the present rate the stock of stored fuel oil held by this company will be depleted within two months and that within five months they will have consumed all the oil purchased for future delivery.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	June 2, 1917	One Year Ago	June 2, 1917	One Year Ago
Buckwheat	.....	$2.05—3.20	$6.00—6.75	$3.25—3.50
Rice	.....	2.50—2.65	5.20—5.85	2.70—2.95
Boiler	.....[1]	.....	.....*	.....
Barley	.....[1]	2.20—2.35	4.90—5.00	2.35—2.60

*No prices quoted

BITUMINOUS

Prices per gross ton for Boston delivery are as follows:

	F.o.b. Mines*		Alongside Boston†	
	June 2, 1917	One Year Ago	June 2, 1917	One Year Ago
Clearfields	$5.50—6 25	$1.15—1.60	$10.75—11.25	$4.25—5.00
Cambrias and Somersets	5.75—6.50	1 40—1.75	11.00—11.50	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $7.50—8.50, as compared with $2.75—2.85 a year ago; on cars Boston price is $13.

*All-rail rate to Boston is $2 60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	June 2, 1917	One Year Ago	June 2, 1917	One Year Ago
Buckwheat	$4.00—4 15	$2.75	$5.75—6.00	$2.65—2.75
Rice	3.40—4.05	2.25	4.50—4.75	2.20—2.25
Barley	2.90—3.10	1.75	3.00—3.25	1.70—1.75

BITUMINOUS

	South Amboy	Port Reading	Mine Price
Clearfield	$7.00—7 25	$7.00—7.25	$5.50—5.75
South Forks	7 50—7.75	.....	6 00—6.25
Nanty Glo	7.50—7.60	.....	6.00—6.25
Somerset	7.15—7.25	7.15—7.25	5.50—5.75
Quehamoning	7.25—7.50	7.25—7.50	6 00—6.25

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	June 2, 1917	One Year Ago	June 2, 1917	One Year Ago
Buckwheat	$2.90	$1.65	$3.80	$2.55
Rice	2.40	.90	3.40	1.80
Boiler	2 20	....	3.30	....
Barley	1.80	.55	2.15	1.30

Pittsburgh—Price of steam coal per net ton f.o.b. mine, Pittsburgh district:

	June 2, 1917	One Year Ago
Slack	$4.75—5.00	$0.95—1.05
Mine-run	4.75—5.00	1.30—1.40
¾-in.	4.75—5.00	1.40—1.50

Add 40c. per ton for freight charge to Pittsburgh.

Chicago—Current price per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Saline and Harrisburg	West Virginia Smokeless	Springfield	Clinton and Sullivan Counties
Steam lump	$3.00—3.75	$3.00—3.75	$5.75—6 25	$3.25	$3.00—3 50
Lump	3.25—3 75	3.25—4.00	5 75—6.50	3.25	3.00—3.50
Egg	3.25—3.75	3.25—4.00	5.75—6.50	3.25	3.00—3.50
Nut	3.25—3.75	3.25—4.00	.....	3.25	3.00—3.50
No. 1 nut	3.25—3.75	3.25—4 00	.....	3.25	.....
No. 2 nut	3.25—3.75	3.25—4.00	.....	....	.....
No. 3 nut	3.00—3.50	3.00—3.75	.....	....	.....
No. 1 washed	3.25—3.75	.....	.....	....	.....
No. 2 washed	3.25—3.75	.....	.....	....	.....
Mine-run	3.00—3 75	2.75—3.50	5.75—6.50	3.00—3.25	3.00—3 50
Screenings	3.00—3.75	2.75—3.50	.....	3.00—3.25	3.00—3.50

Hocking lump, $4.50—4 75; split lump, $4.50—4.75.

St. Louis—Prices per net ton f.o.b. mine a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	June 2, 1917	One Year Ago	June 2, 1917	One Year Ago	June 2, 1917	One Year Ago
6-in. lump	$3.50	$1.50	$2 25	$1.35	$2.00	$1.20
2-in. lump	3.50	1.30	2 25	1.20	1 75	.95
Steam egg	3.50	1.35	2.25	1 25	1.75	.90
Mine-run	3.25	1.25	2 25	1.10	1 75	.90
No. 1 nut	3.50	1.50	2.25	1 30	2.00	1.10
2-in. screen	2 75	1.50	2 25	1.25	1.75	1.10
No. 5 washed	2.75	1.50	2.25	1.20	1.75	1.00

Williamson-Franklin rate St. Louis, 72½c.; other rates, 57½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run		Mine-Run
Pratt	$3.75—4.00	Carbon Hill	$3.25—3.50
Big Seam	3.00—3 50	Cahaba	3.75—4.00
Black Creek	3.75—4.00		

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ala., Mobile—City will hold an election June 25 to vote on $55,000 bonds to be used for erecting certain parts of an overhead freight transmission system, including rails, power chains, stationary motors, etc. H. Pillans, Mayor.

Ga., Chauncey—The Georgia & Southern Utilities Co. plans 18-mi. transmission line to Chauncey, Milan and Ryan to develop 200 hp. C. R. Hodgson, Eastman, Mgr.

Ill., Chicago—The Commonwealth Edison Co., 72 West Adams St., plans to build a 1-story, brick power house at 7675 South Chicago Ave. Estimated cost, $25,000. V. H. Fyfe, Arch.

Ill., Elgin—B. S. Pearsall has purchased the old Waverly mill and will install a hydro-electric plant.

Ill., Emington—Town Board is considering plans for installing an electric-lighting system.

Iowa, Manson—City voted in favor of issuing bonds to build an electric lighting and heating plant. F. P. Wilson, City Engr.

Kan., Abilene—The Riverside Light, Power and Gas Co. will extend its system. M. Buck, Ch. Engr. Power Station.

Kan., Hayes—City has retained E. T. Archer & Co., New England Bldg., Kansas City, Mo., Engrs., to prepare plans for improving the electric-light plant.

Kan., Kensington—City plans to improve its electric-light plant.

Ky., Campbellsville—The Campbellsville Electric Light and Power Co., recently incorporated with $40,000 capital stock, plans to install an electric plant to develop about 125 hp. Estimated cost, $40,000. L. A. Taylor, Aud. and Mgr.

Ky., Paducah—City Comn. plans election to vote on $185,000 bonds to improve the electric-light plant. L. A. Washington, City Engr.

Mass., Ayr—The New England Power Co., Shelburne Falls, is having surveys made for an electric transmission line from its nearest plant to the mobilization camp to be established here, to furnish electricity for lighting the camp and for power purposes. M. S. Allen, 801 Osgood Bradley Bldg., Worcester, Pur. Agt.

Mass., Malden—A committee recently appointed to investigate feasibility of establishing an electric and gas plant, reported in favor. C. Blodgett, Mayor.

Mass., Springfield—A bill is now pending in Congress providing for an appropriation of $90,000 for equipping the Hill plant of the Springfield Armory. Plans include large electric generating units to replace the 450-hp. steam engines now in use.

Mass., Worcester—The Mills Woven Cartridge Belt Co., Webster St., will construct a 51 x 77-ft. boiler house on Fremont St. Estimated cost, $30,000.

Mass., Worcester—The Wachusett Thread Co. will construct a 40 x 75-ft. addition to its boiler house on Cambridge St.

Miss., Summit—McComb & Magnolia Light and Railway Co. plans 7 mi. of transmission line to connect Summit, McComb and Magnolia. A. H. Jones, Gen. Mgr.

N. Y., Buffalo—The Public Service Comn. authorized a $1,500,000 bond issue for the Interantional Railway Co. for extensions and improvements to its system, including addition to its power house and equipment for its substation. J. C. Sheldon, Ellicott Sq., Buffalo, Pur. Agt.

N. Y., Lebanon—The Earlville Electric Light Co. petitioned the Public Service Comn. for authority to issue $8325 bonds to build an electric-light plant.

N. D., Forbes—City plans to install an electric-light plant. Plans include an electric transmission line from Ellendale to Forbes.

Ohio, Marion—The Marion Railway, Light and Power Co. plans to improve its plant, including the installing of a 320-hp. Haine boiler and a boiler pump.

Okla., Billings—Property owners voted $10,000 bonds to improve the electric-light plant.

Penn., Conyngham—The Harwood Electric Co., Hazleton, plans to install a distributing system to supply electricity for commercial lighting and power purposes. E. Hughlies, 43 Chestnut St., Philadelphia, Pur. Agt.

Penn., Philadelphia—The Green Box Co., Memphis St., plans to construct a 30 x 60-ft. power house in connection with its new factory addition. W. E. S. Dyer, Land Title Bldg., Arch.

Penn., Scranton—The Maccar Truck Co. is having plans prepared by Duckworth Bros., Coal Exchange Bldg., Arch., for a 1-story power house at its local plant.

Penn., South Bethlehem—Lehigh Navigation Electric Co. plans a steel tower electric transmission line between Siegfried and the Bethlehem Steel Co.

Penn., Yeadon—Theodore Presser has had plans prepared by J. T. Hoekstra, Arch., for a 50 x 100-ft. power house.

S. C., Jefferson—The State Legislature has granted permission to the city to issue bonds to improve the electric-light plant.

Tenn., Chattanooga—The Lucy Manufacturing Co. is considering building a power house. Estimated cost, $6,500.

Tex., Odessa—The Odessa Light and Power Co., recently incorporated with $4000 capital stock, will construct an electric-light plant in Odessa. R. M. Henderson, W. F. Bates and W. H. Rhodes, incorporators

Va., Richmond—Memorial Hospital, care of Medical College, plans to build a 2-story power house on Marshall St. A. L. Gray, Chm. Bldg. Com. Nolan & Baskerville, Travelers' Inn Bldg., Arch.

Wis., Sparta—The Wisconsin-Minnesota Light and Power Co. will construct 90 mi. of transmission line connecting Sparta, Tomah and La Crosse with the plant at Nelson. This company recently purchased the plants of the O. I. Newton Sons Co. at Sparta and Angelo. W. J. Sicard, Eau Claire, Pur. Agt.

Current Prices—Materials and Supplies

These are jobbers' prices to the power plant

ELECTRICAL SUPPLIES

KNIFE SWITCHES—Following are net prices each in cities named for knife switches mounted on slate base, front connected, punched clip type, 250 volts:

	30 Amp.				60 Amp.			
	New York	Chicago	St. Louis	Dallas	New York	Chicago	St. Louis	Dallas
D. P. S. T., fuseless	$0.91	$0.49	$0.49	$0.68	$1.04	$0.89	$0.88	$1.22
D. P. S. T., fused..	.91	.76	.76	1.06	1.53	1.30	1.30	1.80
D. P. D. T., fuseless	1.45	.84	.84	1.16	1.70	1.44	1.44	2.00
D. P. D. T., fused..	1.87	1.58	1.58	2.20	2.89	2.45	2.45	3.40
T. P. S. T., fuseless	1.36	.73	1.15	1.02	1.57	1.32	1.32	1.84
T. P. S. T., fused..	1.36	1.15	1.15	1.60	2.30	1.94	1.94	2.70
T. P. D. T., fuseless	2.27	1.30	1.92	1.80	2.64	2.23	2.23	3.10
T. P. D. T., fused..	3.10	2.53	2.53	3.52	4.63	3.92	3.92	5.44

	100 Amp.				200 Amp.			
	New York	Chicago	St. Louis	Dallas	New York	Chicago	St. Louis	Dallas
D. P. S. T., fuseless	$2.13	$1.80	$1.80	$2.50	$3.83	$3.24	$3.24	$4.50
D. P. S. T., fused..	3.12	2.64	2.64	3.66	5.75	4.87	4.87	6.76
D. P. D. T., fuseless	3.83	3.24	3.24	4.50	6.38	5.40	5.40	7.50
D. P. D. T., fused..	6.29	5.33	5.33	7.40	11.05	9.36	9.36	11.70
T. P. S. T., fuseless	3.20	2.71	2.71	3.76	5.75	4.87	4.87	6.76
T. P. S. T., fused..	4.68	3.96	3.96	5.50	8.62	7.30	7.30	9.13
T. P. D. T., fuseless	5.87	4.97	4.97	6.90	9.86	8.35	8.35	10.44
T. P. D. T., fused..	10.07	8.53	8.52	10.66	17.68	14.98	14.98	18.72

Lots $25 and more, list.

FUSES—Following are net prices of inclosed fuses each, in standard packages, in cities named:

	New York	Chicago	St. Louis	Dallas	Package
20	$0.13	$0.13	$0.09	$0.13	100
31-60	.18	.18	.12	.18	100
61-100	.46	.46	.32	.46	50
110-200	1.02	1.02	.70	1.02	25
225-400	1.84	1.83	1.26	1.84	25

FUSE PLUGS, PER 100

	New York	Chicago	St. Louis
30	$4.20	$4.50	$3.90

Standard package fuse plugs, 500; 100, less than package, 5c. each.

SOCKETS—Following are net prices in cents each in standard packages in cities named:

	⅛-In. Cap				⅜-In. Cap			
	Pkge.	Key	Keyless	Pull Chain	Pkge.	Key	Keyless	Pull Chain
New York ..	500	23.10	21.00	42.00	250	27.30	25.20	46.20
Chicago	500	23.10	21.00	42.00	250	27.30	25.20	46.20
Dallas	500	23.76	21.60	43.20	250	28.08	25.92	47.52
St. Louis ..	500	21.78	19.80	39.60	250	25.74	23.76	43.56

	Pendant Cap			⅛ In.	Less Than ⅛ More	Package in and Pendant	and
	Package	Key	Keyless	Pull Chain	Than Key	.25 Keyless	Pull Chain
New York	250	23.10	21.00	42.00	27.00	24.00	48.00
Chicago	250	23.10	21.00	42.00	28.05	25.50	51.00
St. Louis	250	21.78	19.80	39.60	26.40	24.00	48.00
Dallas	250	23.76	25.50	43.20	28.05	25.50	51.00

CUT OUTS—Following are net prices each in cities named for standard package quantities:

EDISON PLUG 0-30

	Package	New York	Package	Chicago	St. Louis
D. P. M. L.	50	$0.18	150	$0.17	$0.17
T. P. M. L.	50	.26	100	.24	.24
D. P. S. B.	50	.19	100	.18	.18
T. P. S. B.	50	.32	75	.30	.30
D. P. D. B.	25	.37	100	.34	.34
T. P. D. B.	25	.54	50	.50	.50
3- to 2-wire D. B.	25	.38	100	.35	.35

CARTRIDGE FUSE

	0-30			31-60			61-100		
	New York	Chicago	St. Louis	New York	Chicago	St. Louis	New York	Chicago	St. Louis
D. P. M. L.	$0.33	$0.30¼	$0.30	$0.84	$0.77	$0.77	$1.68	$1.54	$1.48
T. P. M. L.	.48	.44	.44	1.20	1.10	1.10	2.40	2.20	2.21
D. P. S. B.	.42	.38½	.39	1.05	.96¼	.96	...	...	...
T. P. S. B.	.81	.74¼	.74	1.80	1.65	1.65	...	...	...
D. P. D. B.	.78	.71½	.72	2.10	1.92½	1.93	...	...	...
T. P. D. B.	1.35	1.23¾	1.24	3.60	3.30	3.30	...	...	...
3- to 2-wire D. B. ..	.90	.82½	.83	2.52	2.31	2.31	...	...	...

Note—Prices are based on quantities of 100.

SEPARABLE ATTACHMENT PLUGS—Following are prices each in cities named:

	Package	Porcelain	Composition	Package	Side Outlet Current Taps
New York	250	$0.21	$0.28	50	$0.35
Chicago	250	.198	.264	50	.33
St. Louis	250	.16	.17	50	.33

CORD—Following are prices each in cities named, in cents per foot:

	Coil, Foot	New York	Chicago	St. Louis
No. 18 cotton, parallel.....	250	2.83	2.86	2.65
No. 16 cotton, parallel.....	250	3.65	3.90	3.36
No. 18 cotton, reinforced.....	250	4.07	4.47	3.05
No. 16 cotton, reinforced.....	250	4.86	5.51	4.32
No. 18 canvasite.....	250	3.17	4.18	4.00
No. 16 canvasite.....	250	3.88	5.28	4.98
¼-in. loom	250	3.00	3.00	2.40
⅜-in. loom	250	4.50	4.50	4.05
½-in. loom	200	6.00	6.00	5.40
⅝-in. loom	200	7.50	7.50	6.75
¾-in. loom	150	9.00	9.00	8.10
1 -in. loom	100	12.50	12.50	11.25
1¼-in. loom	100	16.50	16.50	14.85
1½-in. loom	100	20.00	20.00	18.00

COPPER WIRE—Following are prices in cents per foot in cities named for rubber-covered wire in standard quantities of 1000 ft.:

	New York			Dallas		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14..	13.50	14.36	26.00	11.50	14.00	33.00
12..	17.70	19.32	38.04	17.00	18.00	38.20
10..	24.30	26.76	53.04	....	....	....
8..	34.50	37.28	74.16	....	....	....
6..	61.24	64.84	....	....	....	....
5..	72.72	76.72	....	....	....	....
4..	78.96	92.64	....	....	....	....
3..	107.20	112.00	....	....	....	....
2..	131.60	136.80	....	....	....	....
1..	171.20	178.00	....	....	....	....
0..	215.00	215.60	....	224.00	224.00	224.00
00..	264.00	264.00	....	273.60	273.60	273.60
000..	325.20	325.20	....	336.00	336.00	336.00
0000..	396.80	396.80	....	408.80	408.80	408.80

	Chicago			St. Louis		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14..	14.00	16.00	28.00	12.00	16.50	30.00
12..	17.82	20.00	41.90	20.55	23.55	46.35
10..	25.08	27.83	61.49	28.95	32.45	64.30
8..	35.80	39.16	87.50	41.10	45.10	89.70
6..	69.75	69.75	....	77.50	78.50	148.14
5..	82.35	82.35	....	92.75	92.75	175.41
4..	98.25	98.25	....	100.58	100.58	201.36
3..	118.75	118.75	....	121.50	121.50	....
2..	144.90	144.90	....	148.05	148.05	....
1..	188.50	188.50	....	192.60	192.60	....
0..	229.90	229.90	....	207.20	207.20	....
00..	286.00	286.00	....	254.00	254.00	....
000..	344.25	344.25	....	312.00	312.00	....
0000..	422.00	422.00	....	380.00	380.40	....

CONDUITS, ELBOWS AND COUPLINGS—Following are New York warehouse net prices per 1000 ft. for conduit and net unit for elbows and couplings:

	Conduit		Elbows		Couplings	
In.	Enameled	Galvanized	Enameled	Galvanized	Enameled	Galvanized
½ ..	$69.70	$74.80	$0.1672	$0.1786	$0.0616	$0.0658
¾ ..	92.00	98.90	.22	.235	.088	.094
1 ..	136.00	146.20	.3256	.3478	.1144	.1222
1¼ ..	184.00	197.80	.4185	.4496	.1581	.1698
1½ ..	220.00	236.50	.558	.5994	.1953	.2098
2 ..	296.00	318.20	1.023	1.10	.2604	.2797
2½ ..	468.00	503.10	1.674	1.80	.372	.3996
3 ..	612.00	657.90	4.464	4.79	.558	.5994
3½ ..	763.60	818.80	9.86	10.59	.744	.7992
4 ..	926.50	991.90	11.39	12.23	.93	.999

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

LOCKNUTS AND BUSHINGS—Following are net prices in New York in standard packages, which are: ½ in., 1000; ¾ to 1¼ in., 100; 1½ to 2 in., 50:

	Locknuts Per 100	Bushings Per 100	Flexible Conduit Box Connections Per 100
½	$1.02	$1.68	$5.62
¾	1.75	4.00	7.12
1	3.00	6.15	10.50
1¼	5.00	8.20	15.00
1½	7.50	10.25	22.50
2	10.00	16.40	30.00
2½	12.30	24.60	67.50

ARMORED CABLES AND BOX CONNECTORS—Following are net prices in New York per 1000 ft. cable and standard package of 100 box connectors in single and double strip:

	Twin Conductor		Three Conductor	
Wire Gage	Cable	Connectors	Cable	Connectors
14	$106.26	$4.50	$75.00	$4.50
12	130.90	4.50	103.95	4.50
10	180.95	4.50	142.45	4.50
8	250.25	5.70	180.95	4.50
6	363.44	8.10	284.90	5.70
4	.....	....	442.75	8.40

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B— Watts	Plain	Frosted	No. in Package	Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.27	$0.30	100	75	$0.65	$0.70	..
15	.27	.30	100	100	1.00	1.05	24
25	.27	.30	100	300	3.00	3.10	24
40	.27	.30	100	500	4.50	4.65	12
50	.27	.30	100	750	6.00	6.25	8
60	.36	.40	100	1000	7.00	7.25	8

Standard package quantities are 10% from above prices. Yearly contracts ranging from $150 up allow a discount of 17% from list.

ELECTRIC FANS—In quantities of 25 to 100, four-blade fans for alternating and direct currents sell in New York as follows:

	Non-Oscillating		Oscillating	
Inch Diameter	110 Volts	Direct Current	110 Volts	Direct Current
0	$8.33	$7.62	$13.25	$11.08
12	13.30	12.00	17.00	15.50
16	16.25	14.00	19.75	18.00

WIRING SUPPLIES—New York prices for tape and solder are as follows:

Friction tape	25c. per lb.	Wire solder	30c. per lb.
Rubber tape	35c. per lb.	Soldering paste	50c. per lb.

MISCELLANEOUS

HOSE—

Fire

	50-Ft. Lengths
Underwriters' 2½-in.	60c. per ft.
Common, 2½-in.	50-10%

Air

	First Grade	Second Grade	Third Grade
¾-in., per ft.	$0.50	$0.28	$0.20

Steam—Discounts from list

First grade... 30% Second grade... 30-5% Third grade... 40-10%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition 50-10% Best grade 25%
Standard 40-10%

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	40%	35%
St. Louis	50%	40%
Chicago	40—5%	35—10%

RAWHIDE LACING—40%.

PACKING—Below are prices each per pound in cities named:

Asbestos

		St. Louis	New York	Chicago
Valve and Stuffing Box	Twisted plain, 25-lb. cartons	$0.80	$0.65@0.70	$1.00
	Twisted graphite, 25-lb. cartons	.90	.90	1.35
	Braided plain, 25-lb. cartons	.80	.80	1.20
	Braided graphite, 25-lb. cartons	.90	1.00	1.55

Asbestos wick in balls, ¼-, ½-, 1-, 25- and 50-lb. cartons, $0.65@0.70, New York; $1, Chicago.

Rubber asbestos, compressed sheets, medium grade about $0.80 in New York and St. Louis; $1, Chicago.

Steam

Following in 25- and 50-lb. cartons:

	New York	Chicago	St. Louis
First grade	$0.83	$1.10	$1.45
Second grade	.55	.85	.90

Rubber and Duck

High grade	$0.44	$0.55	$0.60
Cold water	.28	.30	.40

Piston

Asbestos, duck and rubber	$1.75	$2.00	....
Flax, first grade	.94	1.00	$0.90
Rubber and duck	.90	1.00	.70

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING

Pipe Size	Standard Thickness Per Lin.Ft.
1-in.	$0.27
2-in.	.36
6-in.	.80
4-in.	.60
3-in.	.45
8-in.	1.10
10-in.	1.30

BLOCKS AND SHEETS

Thickness	Price per Sq.Ft.
½-in.	$0.27
1 -in.	.30
1½-in.	.45
2 -in.	.60
2½-in.	.75
3 -in.	.90
3½-in.	1.05

85% magnesia high pressure 15% off

Air cells for low-pressure heating and return lines: 4-ply 58% off; 3-ply 60% off; 2-ply 62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	New York	Chicago	St. Louis
Cup	5@7	7½	4
Fiber or sponge	5@7	7¾	5
Transmission	5@7	6¼	5
Axle	3@7	5	3½
Gear	4@5	6½	3
Car journal (S. & F.)	6½	6	9½

COTTON WASTE—The following prices are in cents per pound:

	New York: May 29, 1917	New York: One Year Ago	Cleveland	Chicago
White	13.00@15.00	12.50	14.00	13.00@15.00
Colored mixed	10.00@12.00	9.00	12.00	10.00@12.00

WIPING CLOTHS—In Cleveland the jobbers' price per 1000 is as follows:

13¼ x 13¼ $35.00 13¼ x 20½ $45.00

In Chicago they sell at $30@33 per 1000.

MANILA ROPE—In New York the price per pound for ⅝-in. and larger, in 1200-ft. coils, is 27¼c. Sizes smaller than ⅝-in. from ½ to 2c. extra per lb. Extra charge of 1c. per lb. for less than 600 ft.

LINSEED OIL—These prices are per gallon:

	New York: May 29, 1917	New York: 1 Year Ago	Cleveland: May 29, 1917	Cleveland: 1 Year Ago	Chicago: May 29, 1917	Chicago: 1 Year Ago
Raw in barrels	$1.31	$0.73	$1.32	$0.75	$1.30	$0.78
5-gal. cans	1.41	.83	1.42	.85	1.35	.83

WHITE AND RED LEAD in 500-lb. lots sell as follows in cents per pound:

	Red: May 29, 1917 Dry	Red: May 29, 1917 In Oil	Red: 1 Year Ago Dry	Red: 1 Year Ago In Oil	White: May 29, 1917 Dry and In Oil	White: 1 Yr. Ago Dry and In Oil
100-lb. keg	12.25	12.50	10.50	11.00	12.00	10.50
25- and 50-lb. kegs	12.50	12.75	10.75	11.25	12.25	10.75
12½-lb. keg	12.75	13.00	11.00	11.50	12.50	11.00
1- to 5-lb. cans	14.25	14.50	12.50	12.50	13.50	12.50

AMMONIA—Below are prices per lb. in cities named:

	Chicago	St. Louis	New York
26-deg. U.S.P. carboys of 100 lb.	..	....*	6¼c.
26-deg. U.S.P. drums of 1000 lb.	6c.	5¾c.	5½c.

*Not used here. Anhydrous ammonia in 100-lb. cylinders costs 25c. per lb. in St. Louis and Chicago.

FIRE BRICK—Quotations on the different kinds in the cities named are as follows f.o.b. works:

	New York	Chicago	St. Louis
Silica brick, per 1000	$50.00@55.00	$50.00@75.00	$50.00
Fire clay brick, per 1000, No. 1	45.00@55.00	.....	45.00
Magnesite brick, per net ton	135.00@145.00	.....	....
Chrome brick, per net ton	135.00	.....	....
Deadburned magnesite brick, per net ton	85.00@90.00	.....	....
Special furnace chrome brick, per net ton	60.00@70.00	60.00@80.00	....

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

FUEL OIL—Price variable, depending upon stock. New York quotations not available owing to this fact. In Chicago and St. Louis the following prices are quoted:

	Chicago	St. Louis
Domestic light, 22-26 Baume	7¾c.	8.5c.

Note—There is practically no fuel oil in Chicago at present time.

POLES—The prices on Western red cedar poles, effective Dec. 21, 1916:

	New York	Chicago	St. Louis	Denver
6 in. by 30 ft.	$5.24	$4.59	$4.59	$3.97
7 in. by 30 ft.	6.90	6.10	6.10	5.30
7 in. by 35 ft.	9.70	8.60	8.60	7.55
8 in. by 35 ft.	11.20	9.90	9.90	8.65
7 in. by 40 ft.	11.35	10.00	10.00	8.75
8 in. by 40 ft.	12.75	11.15	11.15	9.65
8 in. by 45 ft.	15.70	13.70	13.70	11.80
8 in. by 50 ft.	18.35	15.95	15.95	13.65

PORTLAND CEMENT—These prices are for barrels in carload lots, including bags:

	May 29, 1917	One Month Ago	One Year Ago
New York	$2.12	$2.12	$1.27
Jersey City	2.00	2.00	1.21
Boston	2.27	2.20	1.47
Chicago	2.31	2.16	1.36
Pittsburgh	2.31	2.16	1.36
Cleveland	2.44	2.29	1.50
Detroit	2.40	2.25	1.45
Indianapolis	2.44	2.29	1.49
Toledo	2.44	2.29	1.49
Milwaukee	2.43	2.28	1.48
Minneapolis	2.58	2.43	1.63
Duluth	2.58	2.41	1.56
Peoria	2.43	2.28	1.44
Cedar Rapids	2.54	2.39	1.55
Davenport	2.49	2.34	1.45
St. Louis	2.20	2.20	1.40
San Francisco	2.60	2.60	1.90

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh, basing card in effect May 1, 1917:

BUTT WELD

Steel: Inches	Steel: Black	Steel: Galvanized	Iron: Inches	Iron: Black	Iron: Galvanized
⅛, ¼ and ⅜	42%	15½%	¾ to 1½	38%	22%
½	46%	31½%			

LAP WELD

2	42%	27½%	1¼	23%	8%
2½ to 6	45%	35½%	1½	30%	16%
			2	31%	17%
			2½ to 4	33%	20%
			4½ to 6	33%	20%

BUTT WELD. EXTRA STRONG PLAIN ENDS

⅛, ¼ and ⅜	38%	20½%	¾ to 1½	38%	23%
½	43%	30½%			
¾ to 1½	47%	34½%			

LAP WELD. EXTRA STRONG PLAIN ENDS

2	40%	28½%	1¼	24%	8%
2½ to 4	43%	31½%	1½	30%	16%
4½ to 6	42%	30½%	2	32%	19%
			2½ to 4	34%	22%
			4½ to 6	33%	21%

Stock discounts in cities named as as follows:

	New York: Black	New York: Galvanized	Cleveland: Black	Cleveland: Galvanized
¾ to 3 in. steel butt welded	44%	28%	43%	28%
3½ to 6 in. steel lap welded	28%	10%	39%	25%

	Chicago: Black	Chicago: Galvanized	St. Louis: Black	St. Louis: Galvanized
¾ to 3 in. steel butt welded	43%	28%	41.27%	26.27%
3½ to 6 in. steel lap welded	39%	25%	37.27%	22.27%

Malleable fittings, Class B and C, from New York stock sell at 5 and 5% from list price. Cast iron, standard sizes, 34 and 5%.

BOILER TUBES—Discounts on less than carloads from Pittsburgh, freight to be added, effective from Nov. 1, 1916, except 3- to 4½-in. steel from Nov. 20, are as follows:

Lap Welded Steel

1¾ and 2 in.	31%
2¼ in.	28%
2½ and 2¾ in.	34%
3 and 3¼ in.	34%
3½ to 4½ in.	34%
5 and 6 in.	33%
7 to 13 in.	30%

Standard Charcoal Iron

1½ in.	23%
1¾ and 2 in.	35%
2¼ in.	32%
2½ and 2¾ in.	38%
3 and 3¼ in.	43%
3½ to 4½ in.	....
5 and 6 in.	37%
7 to 13 in.	34%

Locomotive and steamship special charcoal grades bring higher prices; 1¾ in., over 18 ft. and not exceeding 22 ft., 10% net extra; 2 in. and larger, over 22 ft., 10% net extra.